The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

August 1943

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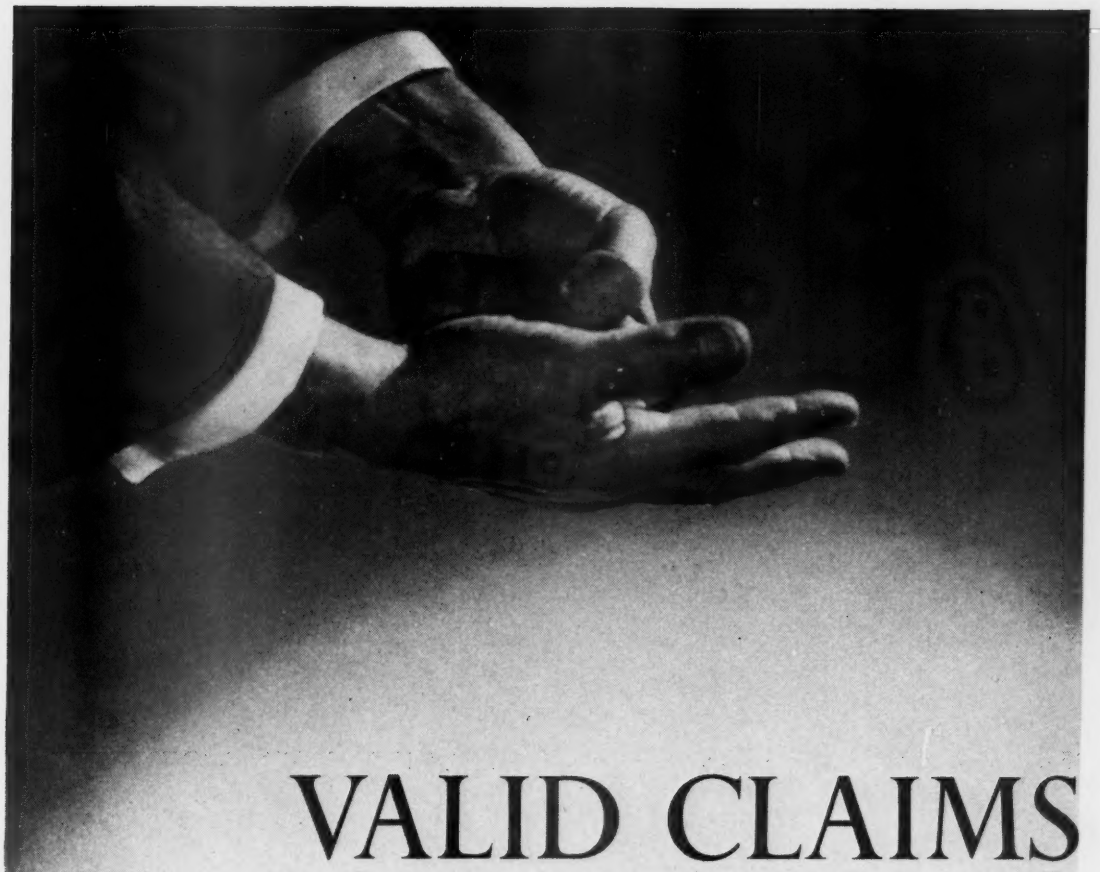

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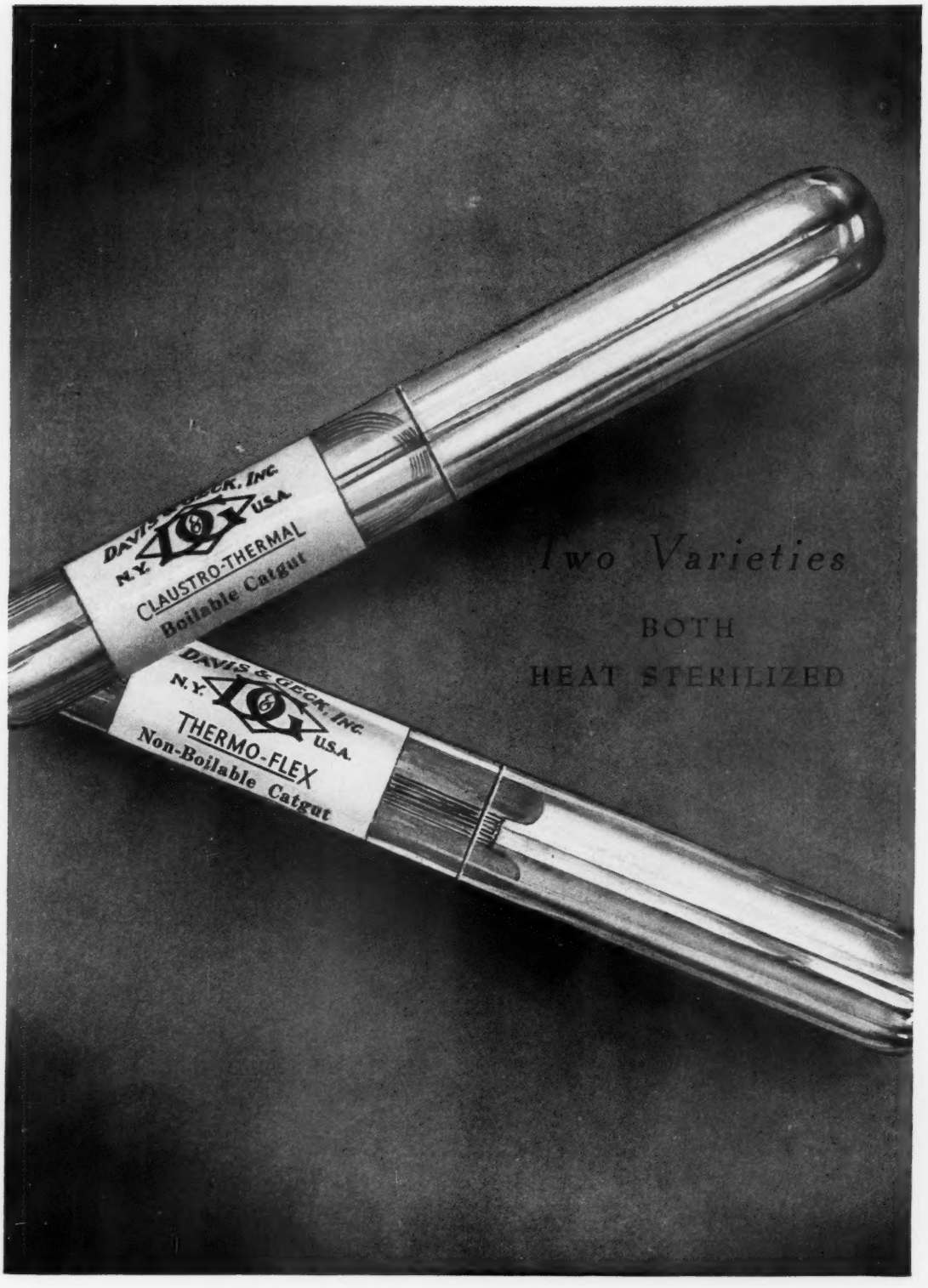

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TO PREVENT leakage of contents, wounds of the intestines or stomach must become air and water tight immediately after suturing. An effective seal is produced and maintained until the regeneration of tissue takes place by the deposition of fibrin between serosal surfaces.

The sutures should, therefore, approximate serosa to serosa and should be so placed as to leave no irregular spaces in which large plugs of fibrin might form.

Closed methods which employ the clamp or cautery to prevent spillage of intestinal contents during suturing should not leave excessive amounts of contused or damaged tissue directly in the suture line. The presence of contused tissue plus even a small number of bacteria, plus sutures which act as foreign bodies, combine to create infection and inflammatory changes which destroy the barrier of fibrin. A persistent leak in the suture line results. Such a leak is a more potent instigator of infection in the peritoneal cavity than the single spillage of a small amount of contents.

The open method of anastomosis avoids the crushing of tissue but causes more bacterial contamination. In either the closed or open method the use of sutures of fine size reduces the amount of foreign body present. Very fine sizes can be used because strength is of secondary importance to the principle of obtaining and maintaining water tightness.

To insure adequate approximation of serosa to serosa at least two layers of sutures are laid. Suturing of the mucosa is almost entirely for the purpose of hemostasis. Whether the sutures employed are interrupted or continuous depends upon the type of material used. Fibrin seals off the interspaces in either case. Unabsorbable sutures tend to move toward the lumen or beneath the serosa. If they are interrupted sutures, those moving toward the lumen fall into it; if continuous, a portion may hang attached for some time. Where this suture pierces the mucosa a small ulcer forms. In the stomach such ulceration may become a chronic non-healing ulcer.

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*Hirsch, M. M., and Novak, M. V.: Evaluation of Germicides with Relation to Tissue Toxicity. Proc. Soc. Exper. Biol. and Med., June, 1942.

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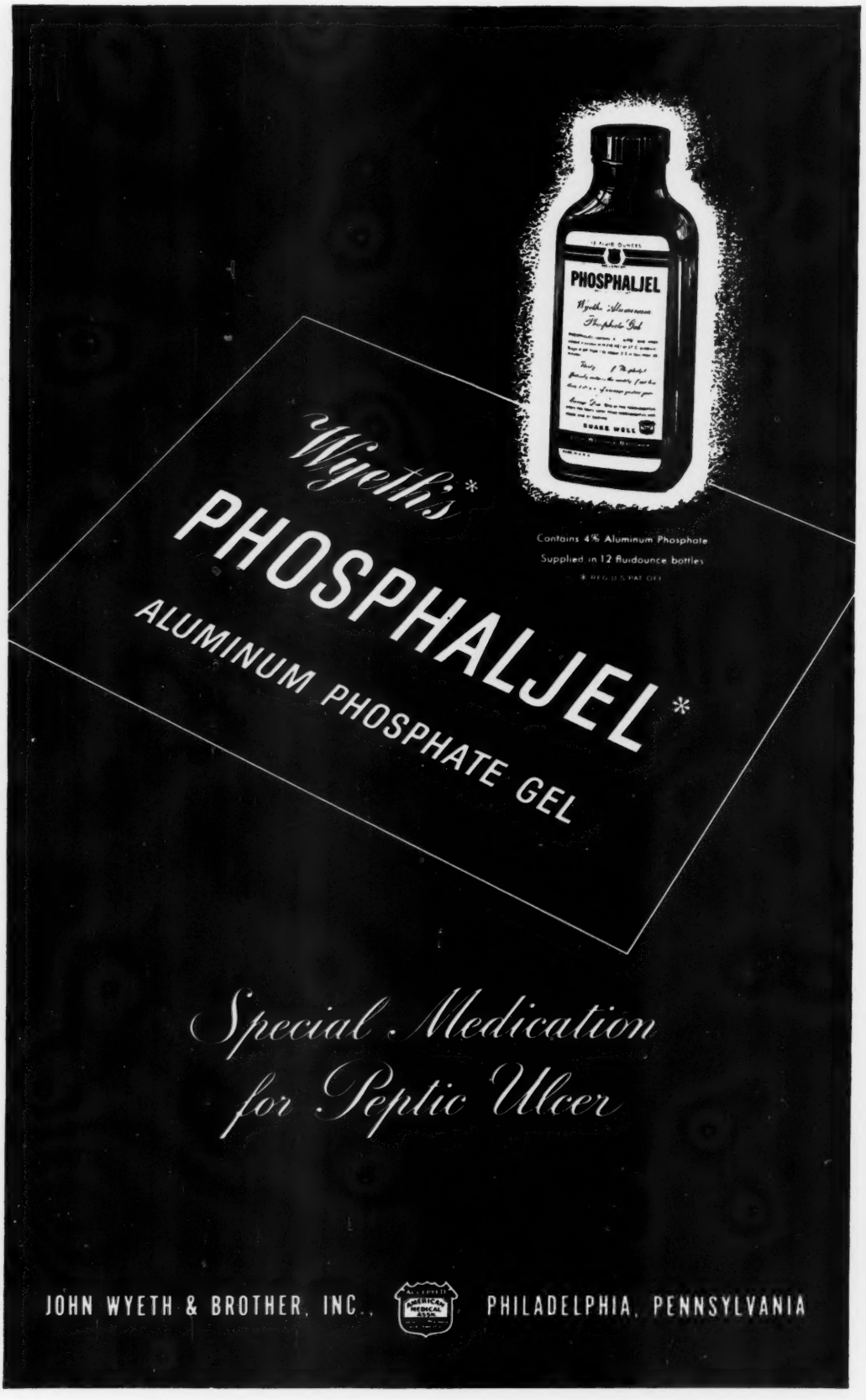
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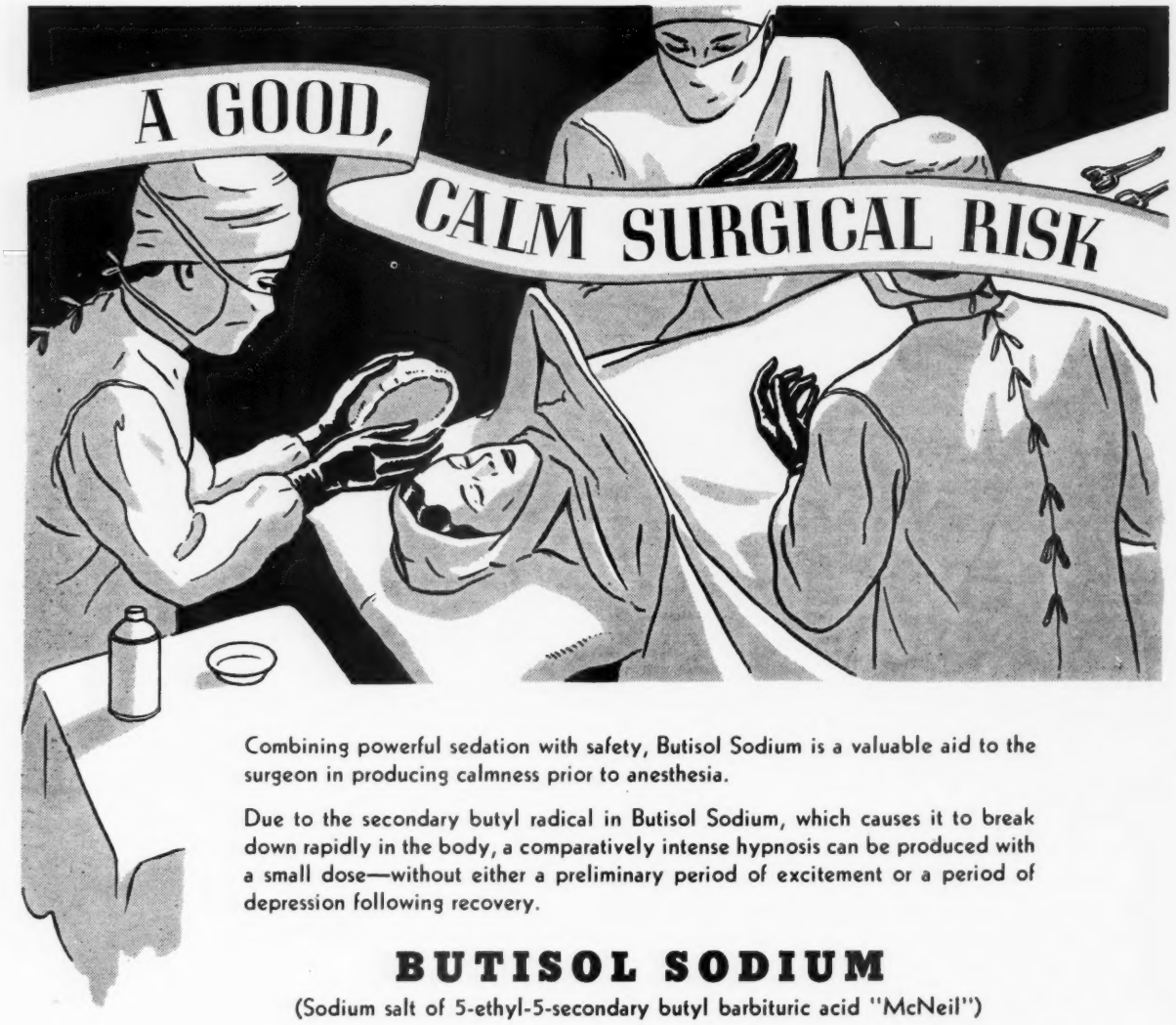

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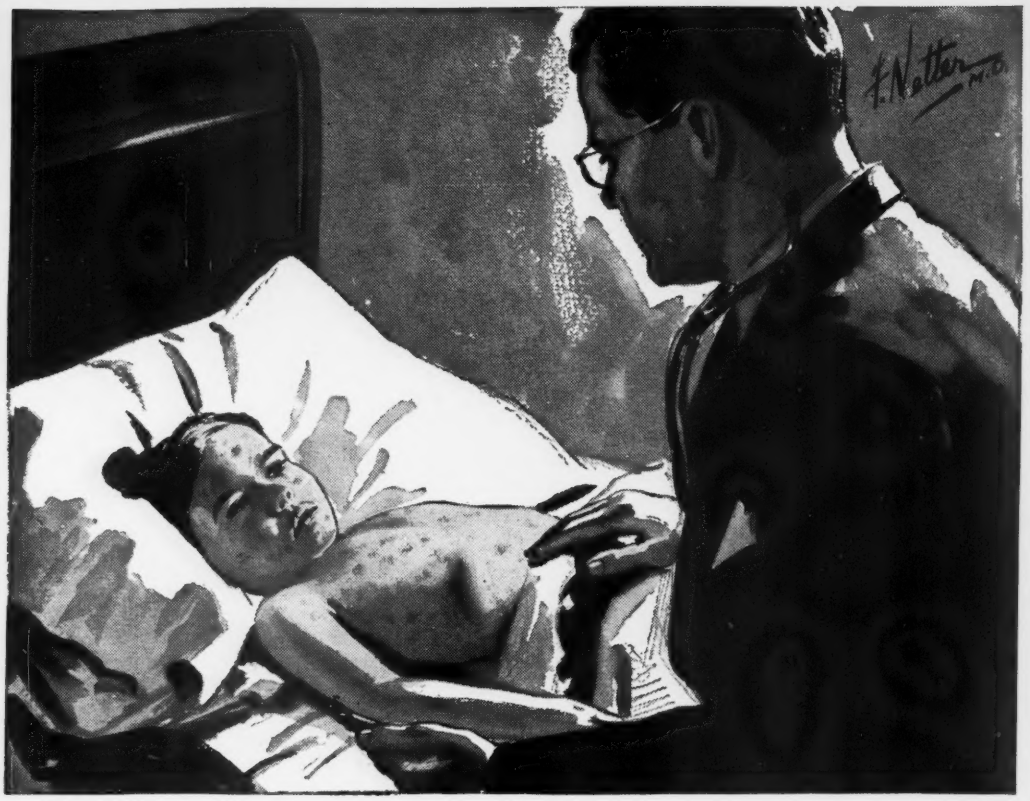

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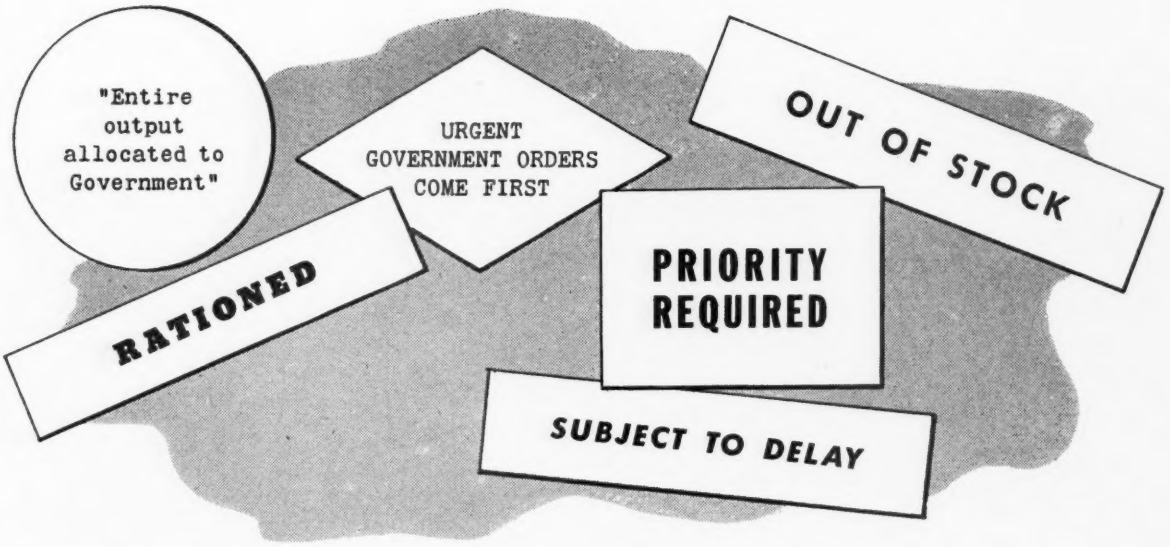

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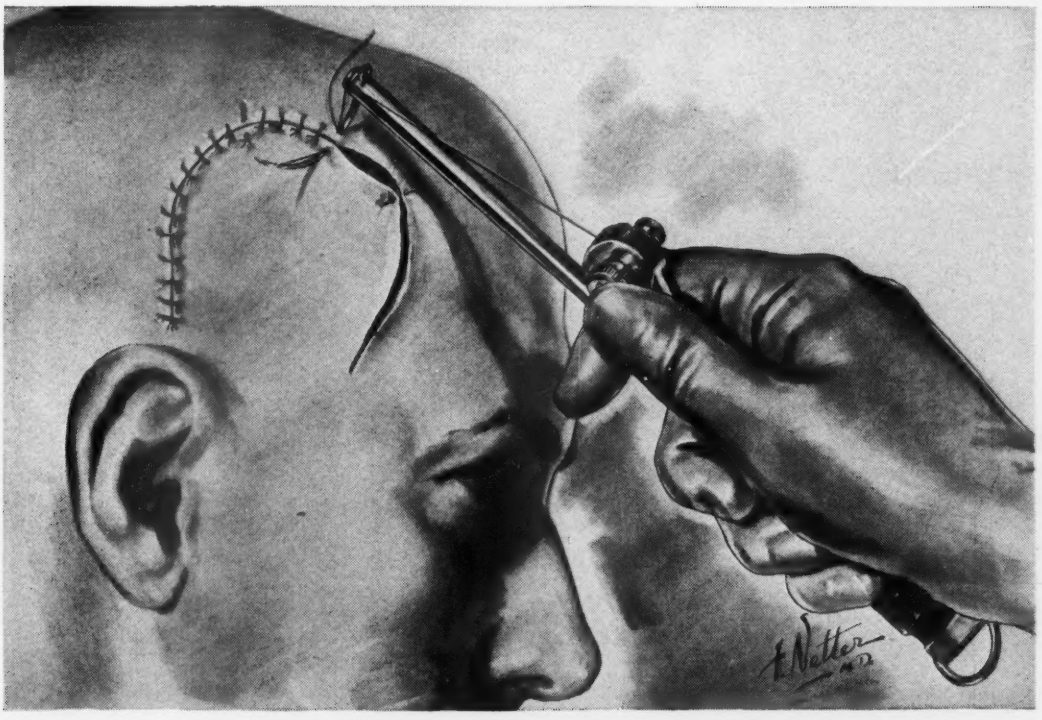

ON-THE-SPOT SURGICAL REPAIR

WARTIME conditions may require more on-the-spot surgery than is now anticipated, for industrial casualties and home accidents often necessitate quick repair.

The Singer Surgical Stitching Instrument has a proved value to busy surgeons. Rethreading and needleholders are eliminated. A variety of new stitches are at the operator's command, insuring more complete closure and added comfort to the patient.

Demonstrations of the Singer Surgical Stitching Instrument may now be arranged for at Singer shops in most cities.

Write Dept. A for descriptive booklet

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SINGER
Surgical Stitching
INSTRUMENT
The Singer Surgical Stitching Instrument is light and well-balanced. Since all parts are rust-proof it may be sterilized as a unit. After it is quickly taken apart for cleaning it may be reassembled in one minute.

SINGER SEWING MACHINE CO., ROOM 726 • 149 BROADWAY, NEW YORK, N. Y.

On the trail

WAY back in the sixties, when the West was young and wild, William R. Warner's drugs were making friends with the medical profession. Country doctors jogged out to lonely farms and ranches with their saddlebags of Warner medicinals ready for use.

Medicine and pharmacy have come a long way from those early days and so has the house of William R. Warner & Co., Inc., whose products are now known and prescribed by medical men all over the world, in fulfillment of the early chosen motto, "Omnis Orbis". Now, as then, the house of Warner remains true to the spirit of the pioneers in its endeavor to help advance the frontiers of pharmaceutical science by continuing the search for still better and safer means of preventing and controlling human disease.

OMNIS ORBIS
WARNER
ESTABLISHED 1856

WILLIAM R. WARNER & CO., INC.

113 West 18th St., New York, N. Y. • 404 South 4th St., St. Louis, Mo.

BRANCHES AND AGENCIES IN SEVENTY-FIVE FOREIGN COUNTRIES

For Victory - Freedom - Life

UNENDING battles are going on within the great battles that rage throughout the globe — but these are battles for life, not death. Arms borne by our military surgeons are modern drugs and surgical instruments of the finest type. A goodly percentage of these instruments carry the name of Sklar—trusted the world over during peace, and now fulfilling their purpose in the skilled hands of surgeons attached to every branch of our armed services.

J. SKLAR MANUFACTURING COMPANY
LONG ISLAND CITY, N. Y.

War demands have limited the instruments available for civilian use. We shall continue to do our best to supply essential civilian requirements. But for safety's sake, care well for the instruments you now have —make them last as long as possible.

WITH THE ARMORED DIVISIONS

LINN BAIL

Two Important Forward Steps in *Vitamin Therapy*

1

For Severe Deficiencies of the water-soluble vitamins

Make this formula available to all physicians

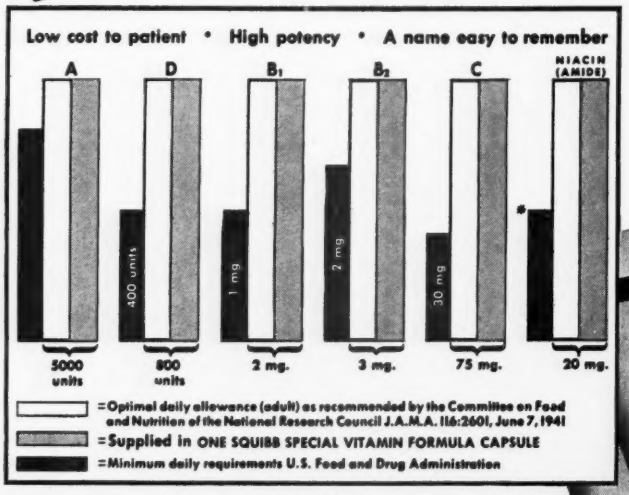
SPIES,[1] JOLLIFFE AND SMITH[2] report that in treating patients with deficiency disease they supply the water-soluble vitamins routinely by the use of a "basic formula." To quote Spies[3]—"It is better to prescribe too much than too little, too soon rather than too late. . . . In treating the clinical syndromes of beri-beri, pellegra, riboflavin deficiency and scurvy, we use a formula containing 10 mg. thiamine, 50 mg. niacin, 5 mg. riboflavin and 75 mg. ascorbic acid. If the symptoms of one deficiency predominate we add to the basic formula more of the vitamin specific for the predominating deficiency"

[1] Spies, T. D.: *M. Clin. North America* 27:273, March 1943.
[2] Jolliffe, N., and Smith, James J.: *M. Clin. North America* 27:567, March 1943.
[3] Spies, T. D.: *J. A. M. A.* 122:497, June 19, 1943.

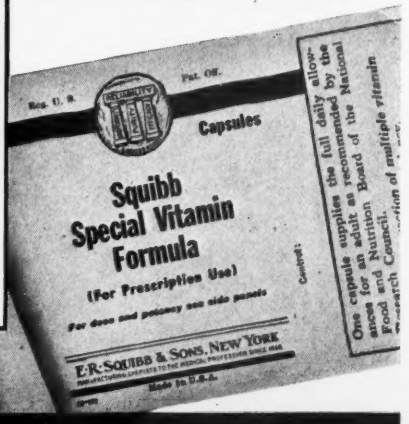
2

For Generalized Vitamin Deficiencies

Optimal Multivitamin Supplementation in one capsule daily.



Low Cost to Patient
High Potency
A Name Easy to Remember



For further information see your Squibb Representative or address Professional Service Dept., 745 Fifth Avenue, New York 22, N. Y.

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MANUFACTURING CHEMISTS TO THE MEDICAL PROFESSION SINCE 1858

THE GREATER POSTSURGICAL PROTEIN REQUIREMENT . . .

From Where in Wartime?

Tissue damage at surgery, and the stepped-up metabolism required for the resultant extensive repair and maintenance, lead to increased nitrogen excretion and possible body protein wastage. To keep the patient in positive nitrogen balance, the intake of protein foods must be sharply advanced.

Even in wartime, with its curtailment of foods for civilian consumption, this greater protein need is met without difficulty, if cereal proteins are accorded the recognition they deserve.

Cereal breakfast foods—natural whole-grain or restored for vitamins and minerals to whole-grain values—contain an average of about 10% of protein (approximately 3 Gm. per ounce), their actual contents ranging from 7% to 14%, depending on the grain from which derived. Their protein is highly acceptable to the human organism, contributing to growth as well as maintenance.

When one ounce (prepared cereal or its equivalent in cereals to be cooked) is served with two ounces of milk and a teaspoonful of sugar, this palatable dish presents about 5 Gm. of protein, rendered biologically adequate through the contained milk, 30 Gm. of carbohydrate, and 2½ Gm. of fat, a total of 165 calories.

In addition it contributes to the diet appreciable amounts of vitamin A, B-complex, and calcium, iron, phosphorus, and magnesium.

The remarkably low fiber content of most cereal breakfast foods —an average of 1.3%—also recommends them for early postsurgical administration. They are dependably bland, easily digested, and usually prove acceptable when many other foods are rejected by the patient.

The presence of this seal indicates that all nutritional statements in this advertisement have been found acceptable by the Council on Foods and Nutrition of the American Medical Association.

CEREAL INSTITUTE INC.

135 SOUTH LA SALLE STREET · CHICAGO

A cooperative effort to present the nutritional value of cereal breakfast foods (natural whole-grain or restored for vitamins and minerals to whole-grain values), undertaken jointly by THE CREAM OF WHEAT CORPORATION . . . GENERAL FOODS CORPORATION . . . GENERAL MILLS, INC. . . . KELLOGG COMPANY . . . NATIONAL BISCUIT COMPANY . . . PILLSBURY FLOUR MILLS COMPANY . . . THE QUAKER OATS COMPANY.

NOW.. ANTISEPTIC COSTS LOWERED AS MUCH AS 80%

New Concentrate Makes Surgical Germicide for 40c a Gallon

A development of utmost importance to every physician and surgeon is this new concentrate for preparing antiseptic solutions and tinctures for surgical use—

CEEPRYN

Brand of Cetylpyridinium Chloride

CONCENTRATED SOLUTION

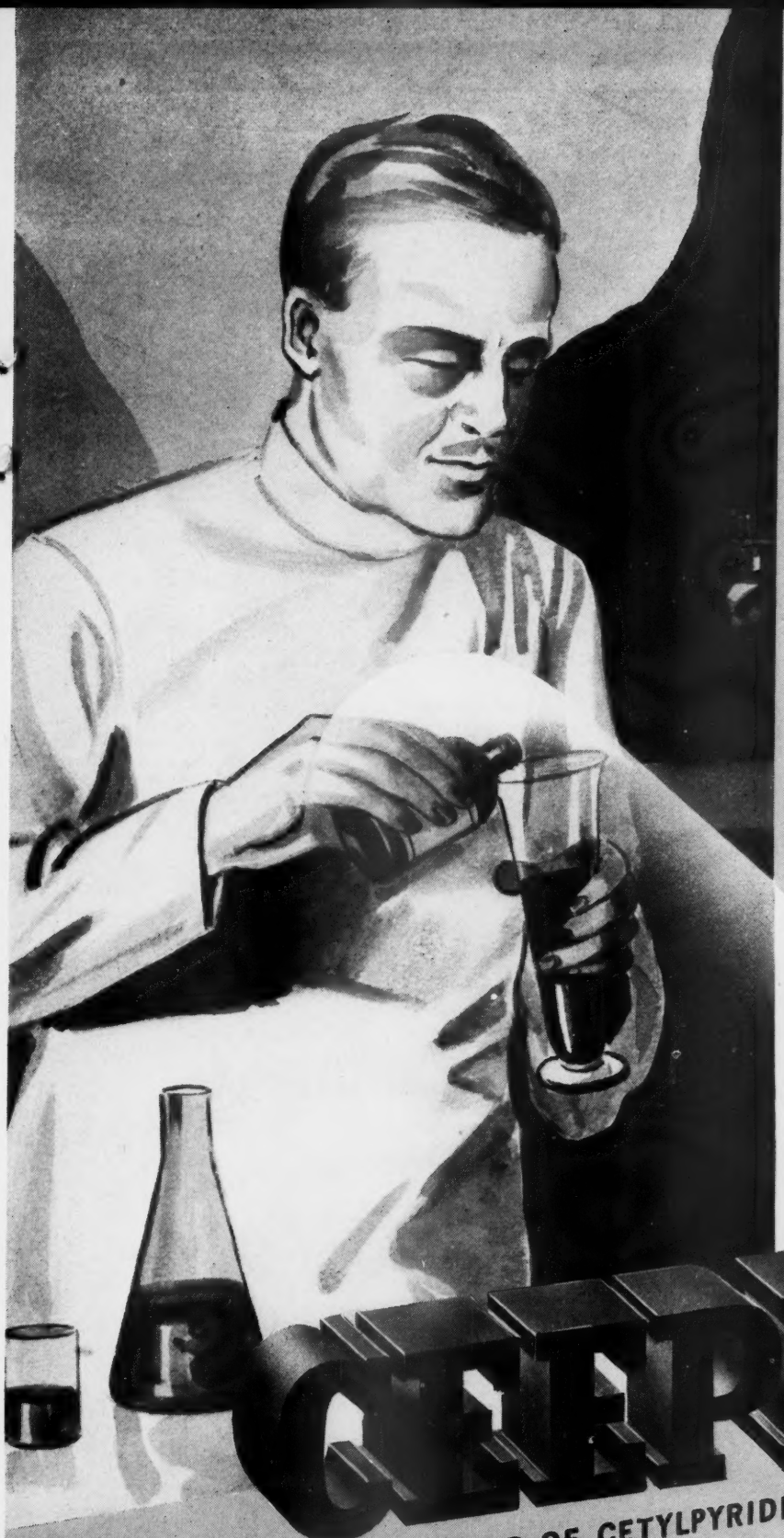
The new product is a 10.56% solution of Ceepryn, quaternary ammonium salt germicide which is well known for its potent and non-selective bactericidal action, penetrating ability, unique detergent property, and exceptionally low tissue toxicity.

By using Ceepryn Concentrated Solution, antiseptic tinctures and solutions can be prepared by the hospital at costs which represent tremendous savings when compared with prices formerly paid for surgical germicides, for example:

AQUEOUS SOLUTIONS — *Cost per Gallon*	
Ceepryn (1:1000) prepared from concentrate	$ .40
Another non-mercurial antiseptic (1:1000)	$5.00
A representative mercurial antiseptic (1:1000)	$6.24
TINCTURES — *Cost per Gallon*	
*Ceepryn (1:500) prepared from concentrate	$1.46
*Ceepryn (1:200) prepared from concentrate	$2.66
Another non-mercurial antiseptic (1:1000)	$6.25
A representative mercurial antiseptic	$7.02
Another representative mercurial antiseptic (1:200)	$21.24
Tincture Iodine (7%)	$4.50

* *Ceepryn tincture costs based on tax-free alcohol (available to most large hospitals) at 65c per gallon and acetone at $2.60 per gallon.*

THE WM. S. MERRELL COMPANY



Ceepryn Concentrated Solution is easy to use. Aqueous solutions are made simply by diluting with the required quantity of distilled water; tinctures by diluting with distilled water, alcohol and acetone. Tinctures may be tinted by adding the special Ceepryn Color Solution available for this purpose. Full directions and formula tables are on the package.

Ceepryn Concentrated Solution is supplied in 180 cc. bottles which can be purchased by hospitals at $2.00 each. Ceepryn Color Solution is offered in 30 cc. bottles at $1,00 each. Also available for office use from your druggist at slightly higher cost.

Specify CEEPRYN for surgical preparation of your patients

CEEPRYN

BRAND OF CETYLPYRIDINIUM CHLORIDE

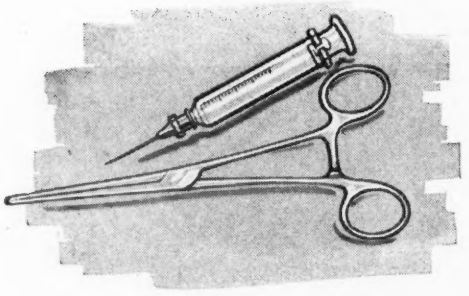
CONCENTRATED SOLUTION

MERRELL

115th Year

Trade Mark "Ceepryn" Reg. U. S. Pat. Off.

Founded 1828 • Cincinnati, U. S. A.



Circulatory Stimulation

is fast and prolonged . . . undesirable side effects are rare
. . . effectiveness is undiminished by repeated use

Neo-Synephrine

Hydrochloride

(laevo—alpha—hydroxy—beta—methyl—amino—3 hydroxy ethylbenzene hydrochloride)

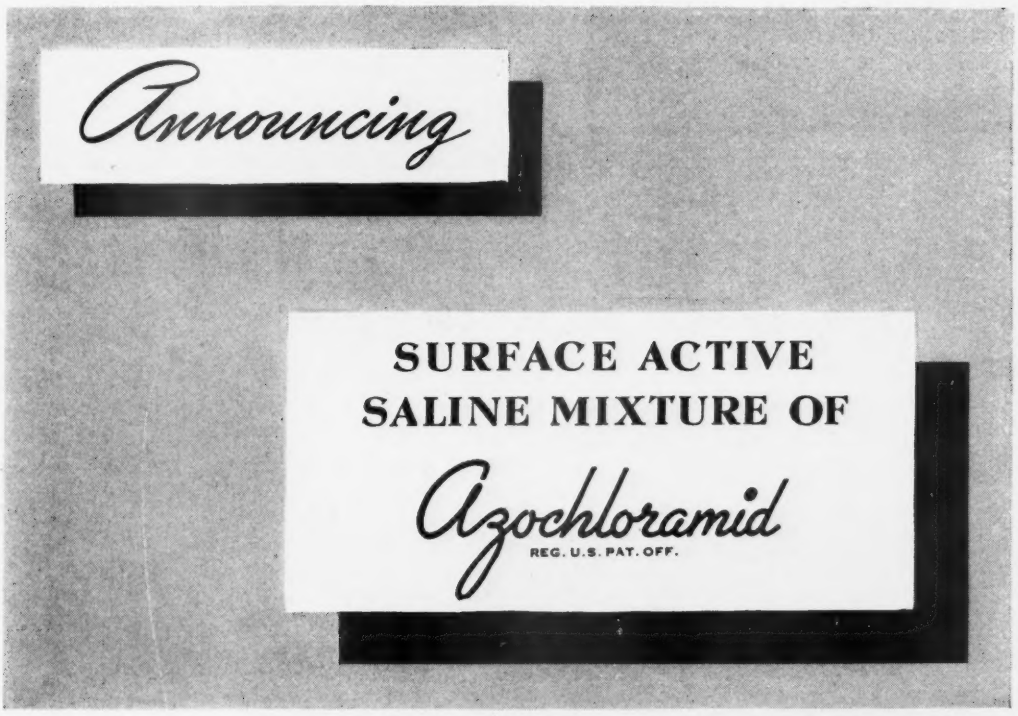
ACCEPTED AMERICAN MEDICAL ASSN

Supplied in 1 c.c. ampuls, and in rubber-capped vials containing 5 c.c. of a sterile 1% solution. Average subcutaneous dose: 0.5 c.c.

Frederick Stearns & Company

Since 1855 . . . ESSENTIALS OF THE PHYSICIAN'S ARMAMENTARIUM

NEW YORK KANSAS CITY **DETROIT, MICH.** SAN FRANCISCO WINDSOR, ONTARIO
SYDNEY, AUSTRALIA AUCKLAND, NEW ZEALAND



In this new preparation the acknowledged bactericidal power of aqueous solutions of Azochloramid* gains new clinical effectiveness by the addition of sodium tetradecyl sulfate—a surface active compound.

The solution of Surface Active Saline Mixture of Azochloramid contains: Azochloramid (1:3300)—noted for its non-selective, persistent bactericidal action—*and* sodium tetradecyl sulfate (1:1000)—demonstrated to be an effective dispersing agent and surface tension depressor. It is isotonic and buffered to pH 7.4.

**Brand of* CHLOROAZODIN U. S. P.

Clinical reports attest the value of this new *bactericide—wetting agent* solution. It is effective for either prophylaxis or treatment of localized infection and is especially indicated where dispersion and removal of pus and débris from infected wound surfaces and cavities are essential. Physicians will find wide use for this stable chlorine solution as a lavage during surgical débridement, for irrigations and instillations, for wet dressings and for hot compresses.

☆ ☆ ☆

Available in powder form in bottles to prepare 1 gallon and 25 gallons of the aqueous solution at hospital and prescription pharmacies. Literature and samples on request.

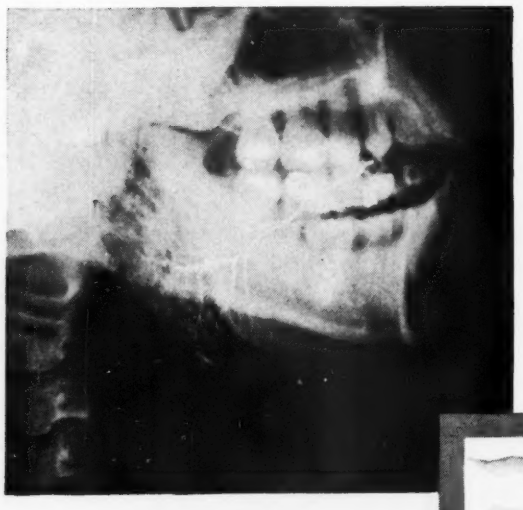
BUY BONDS

WALLACE & TIERNAN PRODUCTS, INC.
BELLEVILLE, NEW JERSEY, U. S. A.

W & T

TECHNIC OF LIPIODOL INSTILLATION

SIALOGRAPHY



The salivary ducts and their ramifications within the parotid and submaxillary glands are readily visualized with Lipiodol—iodized poppy-seed oil containing 40 per cent iodine in chemical combination. This diagnostic procedure demonstrates the presence of salivary fistulas, calculi, and foreign bodies. It serves to differentiate the gland from surrounding structures and permits differentiation between intrinsic and extrinsic tumors. The method is contraindicated in acute parotitis.

The technic advised by Blady and Hocker* is relatively simple. The duct papilla is identified and anesthetized with a 10 per cent cocaine solution. The duct is dilated for a distance of 1 cm. with a fine probe. The needle employed is 20 gauge and 3 inches long, with a blunted point. It is attached to a tuberculin syringe into which Lipiodol (warmed to body temperature) has been aspirated. The needle is inserted into the duct for a distance of 1 cm. and 1.0 to 1.75 cc. of Lipiodol is slowly instilled. Roentgenograms are made on a Potter-Bucky table.

*Blady, J. V., and Hocker, A. F.: The Application of Sialography in Non-Neoplastic Diseases of the Parotid Gland, Radiology *32*:131-140 (Feb.) 1939.

The many uses of Lipiodol are graphically presented by text and illustrations in a new brochure "The Applicability of Lipiodol in Roentgenography and the Technic of its Use." Physicians are invited to send for a complimentary copy.

ACCEPTED AMERICAN MEDICAL ASSN

E. FOUGERA & CO., INC., *Distributors*
75 Varick Street New York, N. Y.

LIPIODOL (LAFAY)

Lipiodol is supplied in a variety of ampule sizes and in a 20cc. vaccine type vial for economy of use.

margin of safety without waste

White's
NEO MULTI-VI CAPSULES
EACH CAPSULE CONTAINS:
Vitamin A 5,000 U.S.P. Units
Vitamin D 500 U.S.P. Units
Thiamine Hydrochloride, U.S.P. (Vitamin B1, 500 U.S.P. Units) 1.5 mg.
Riboflavin 2.5 mg.
Pyridoxine Hydrochloride (Vitamin B6) 1 mg.
Calcium Pantothenate 1 mg.
Nicotinamide 20 mg.
Ascorbic Acid, U.S.P. (Vitamin C, 1,000 U.S.P. Units) 50 mg.

Unless protective steps are taken, certain patients are almost bound to develop some degree of multiple vitamin deficiency.

A completely adequate diet in pregnancy and lactation is often impractical when gastric distress or anorexia impair dietary intake.

Following major surgery, restricted diet and the prolonged use of parenteral fluids are frequent causes of multiple avitaminosis.

Chronic gastrointestinal disorders associated with impaired digestion and absorption, inevitably give rise to nutritional failures. The increased metabolic demands of the febrile patient and the anorexia of the convalescent are similar indications for dietary reinforcement.

White's Neo Multi-Vi Capsules are formulated to provide a good safety margin beyond daily minimum requirements of every known vitamin, yet not wastefully in excess of the patient's needs or ability to utilize.

WHITE'S NEO MULTI-VI CAPSULES

Each capsule contains:

Vitamin A	5000 U.S.P. Units
Vitamin D	500 U.S.P. Units
Thiamine Hydrochloride, U.S.P.	1.5 mg.
Riboflavin	2.5 mg.
Pyridoxine Hydrochloride	1 mg.
Calcium Pantothenate	1 mg.
Nicotinamide	20 mg.
Ascorbic Acid, U.S.P.	50 mg.

Supplied in bottles of 25, 100, 500, 1000 and 5000 capsules. Ethically promoted—not advertised to the laity. White Laboratories, Inc. Pharmaceutical Manufacturers, Newark 7, N. J.

WHITE'S MULTI-VI CAPSULES

Well-rounded vitamin support for milder deficiencies and prophylaxis. Economically priced. Bottles of 25, 100, 500, 1000 and 5000 capsules.

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White's PRESCRIPTION vitamins

Phe-Mer-Nite Tincture and Solution offer the surgeon valuable antiseptic properties. As a preoperative skin disinfectant, the tincture (1:3000 alcohol-acetone-aqueous solution) is nontoxic, nonirritant, quickly effective. It produces dependable skin sterilization in 3 minutes. Soap and water readily remove the color. Phe-Mer-Nite Solution (1:1000) retains its high bactericidal power in the presence of blood serum, and finds many uses in every day practice in the physician's office, at hospitals, and in industrial plants.

PHE-MER-NITE

(Brand of Phenylmercuric Nitrate)

Virtually nontoxic. Does not precipitate tissue proteins. Diluted 1:4 (water) the Solution sterilizes instruments and rubber gloves harmlessly in 5 minutes. This Solution may be applied to burns and other lesions requiring antisepsis. Phe-Mer-Nite Tincture and Solution are supplied in gallon and pint bottles. Surgeons are invited to send for literature and liberal clinical test samples.

THE S. E. MASSENGILL COMPANY

Bristol, Tenn.-Va.

NEW YORK • SAN FRANCISCO • KANSAS CITY SEMCO

Sodium Morrhuate

Obliterative treatment of varicose veins with **CHEPLIN'S SODIUM MORRHUATE** is well established clinically — acting rapidly, effectively and safely. This modern sclerosing solution is practically painless, causes no bruising and does not produce necrosis if accidentally injected outside the vein—as may occur with some other sclerosing solutions. Literature on request.

SODIUM MORRHUATE is supplied as 5% solution in:

2 cc. ampules . .	in boxes of 12, 25 & 100
5 cc. ampules . . .	in boxes of 6, 25 & 100
30 cc. vials	single or in boxes of 12
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"ACCEPTED STANDARDS AT AN ACCEPTABLE COST"

CHEPLIN BIOLOGICAL LABORATORIES, INC.

(Division of Bristol-Myers)

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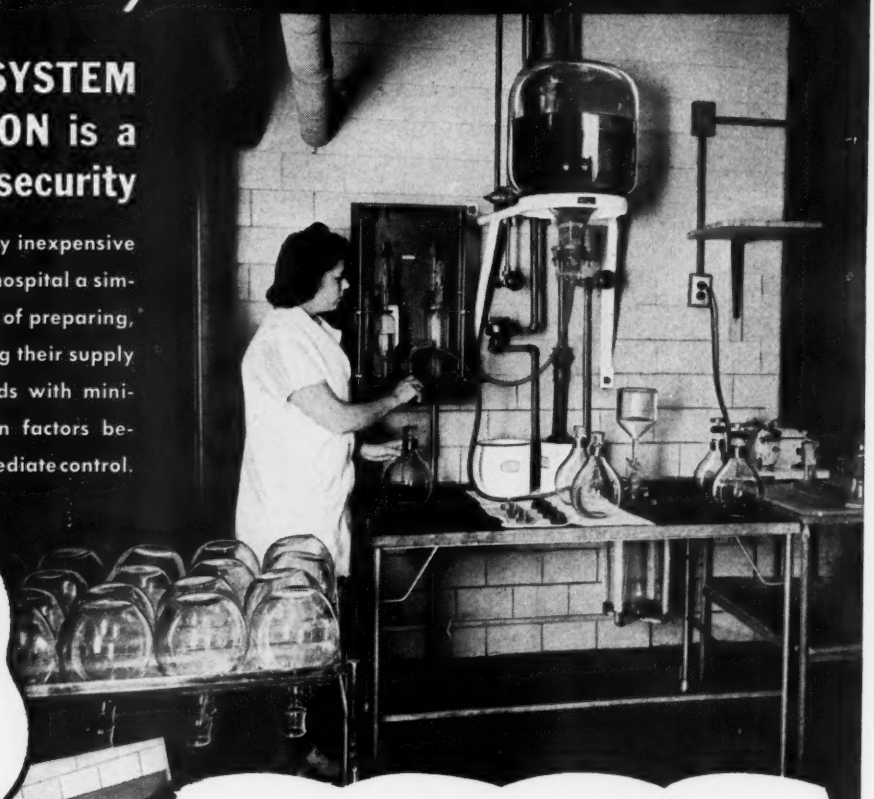
For an unpredictable tomorrow...

A FENWAL SYSTEM INSTALLATION is a measure of security

This complete, relatively inexpensive equipment affords the hospital a simplified, accurate means of preparing, storing and replenishing their supply of safe parenteral fluids with minimum dependence upon factors beyond the hospital's immediate control.



PREPARATION UNITS • STORAGE UNITS • BLOOD COLLECTING UNITS • ADMINISTRATION UNITS

Send for descriptive brochure

These highlights are important—

Enables the hospital to prepare their requirements at an amazingly low per-liter cost . . . cuts expense.

Multi-sized Fenwal Container-dispensers and TEL-O-SEAL hermetic closures can be used repeatedly. They provide for safe storage under 29 inches of vacuum . . . indefinitely. A Tel-O-Seal fits any size container.

The sterility of solutions may be periodically checked without breaking the hermetic seal or contaminating the contents.

Administration is made from original containers.

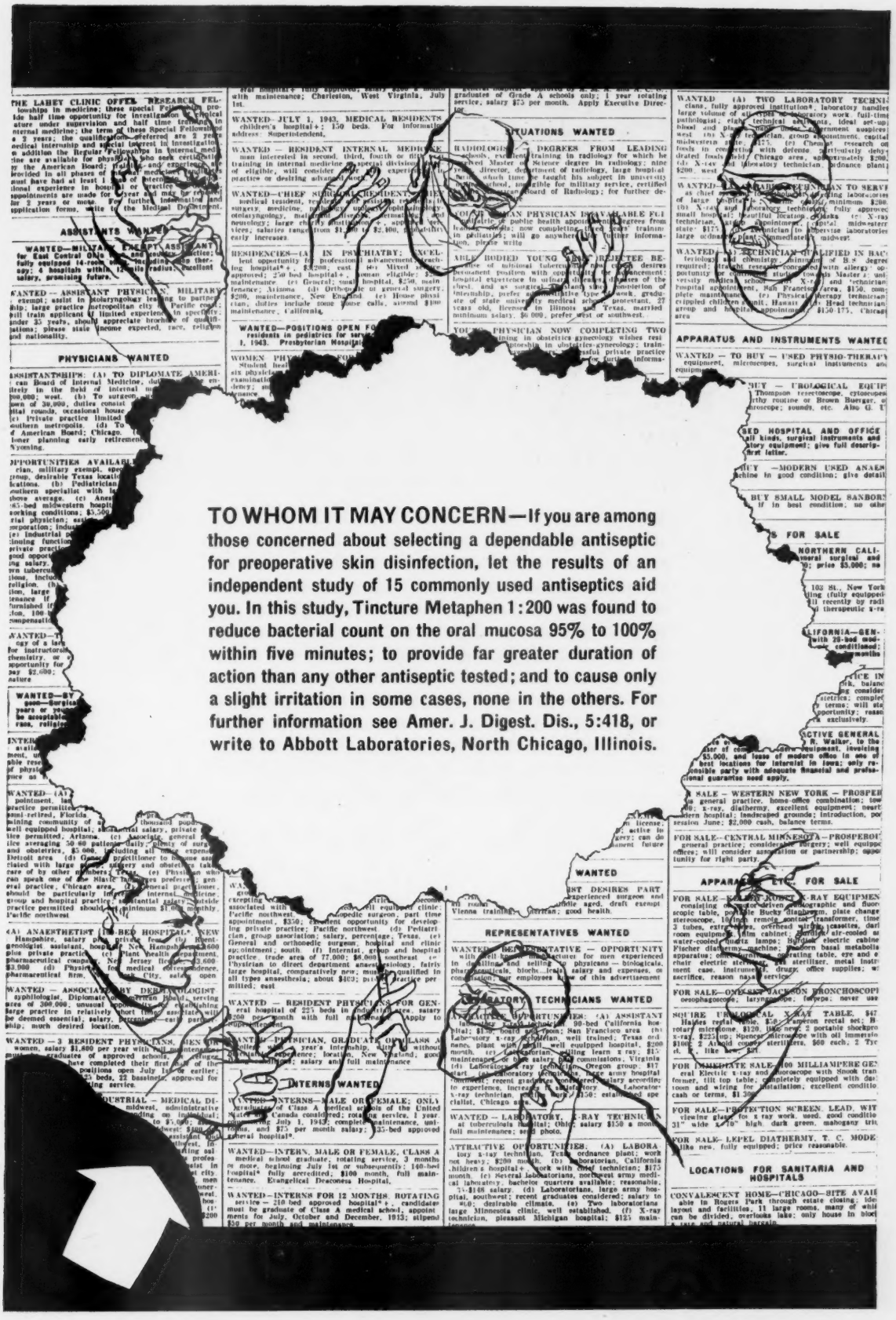
Containers and equipment are designed to facilitate rapid, thorough cleansing.

We invite your direct inquiry

MACALASTER BICKNELL COMPANY
243 Broadway Cambridge, Massachusetts

Fenwal

THE SOLUTION DESIRED AT THE INSTANT REQUIRED


TO WHOM IT MAY CONCERN—If you are among those concerned about selecting a dependable antiseptic for preoperative skin disinfection, let the results of an independent study of 15 commonly used antiseptics aid you. In this study, Tincture Metaphen 1:200 was found to reduce bacterial count on the oral mucosa 95% to 100% within five minutes; to provide far greater duration of action than any other antiseptic tested; and to cause only a slight irritation in some cases, none in the others. For further information see Amer. J. Digest. Dis., 5:418, or write to Abbott Laboratories, North Chicago, Illinois.

PRIODAX

TABLETS

for dependable cholecystograms

Accurate gallbladder diagnosis is now more certain with PRIODAX, a new contrast medium which owes its superiority to its form and composition.

Iodine, (51.5%) firmly bound, in a stable organic molecule produces reliable, clear pictures of uniform density by the "single-dose" method.

Contains no phenolphthalein or any related derivatives, thus reducing the possibility of diarrhea with loss of contrast material.

Tablet Administration and chemical nature favor retention. Vomiting ...so often associated with unpalatable powders...is *rare* with PRIODAX.

Administration: Six tablets swallowed whole in the course of a light fat-free evening meal. X-ray exposures are made in 12 and 15 hours.

PRIODAX, β-(4-hydroxy-3, 5-diiodophenyl)-α-phenyl-propionic acid, supplied in cellophane envelopes, each containing six tablets. Boxes of 1, 5 and 25 envelopes.

FOR VICTORY AND AFTER...BUY WAR BONDS

SCHERING CORPORATION · BLOOMFIELD · N.J.

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"FUTURES"

NO. II

THE TRANS-ILLUMINATED FIELD . . . Forecast for the future is a new method of lighting for surgery, with complete illumination of the operative field, enabling the surgeon to see a three-dimensional area clearly. Shadows and glare would be eliminated. The circulation in the tissues and organs would be observable throughout the operation. For modern advancements in suture making see following pages. ➔

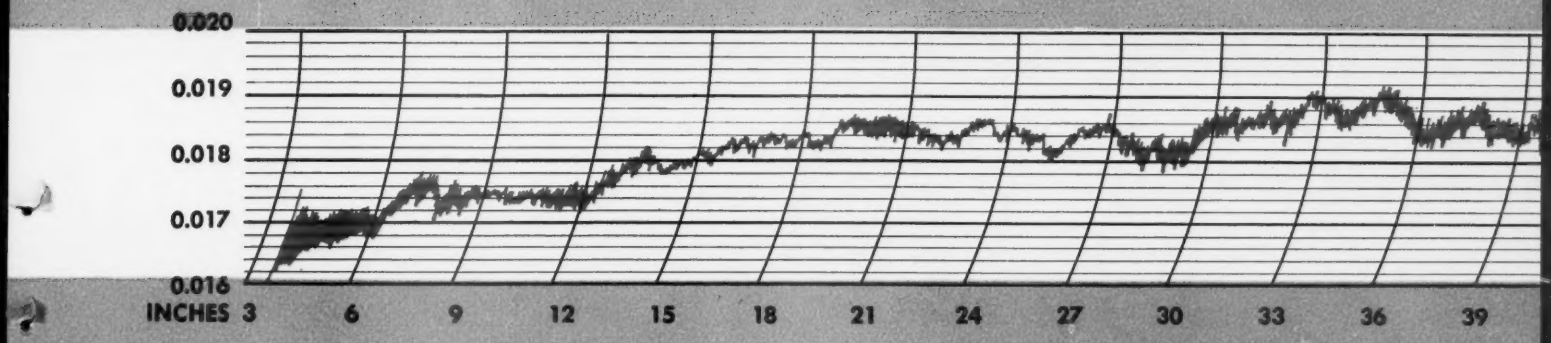
Now four scientific developments improve catgut sutures

● Johnson & Johnson is proud to present the new Ethicon, which embraces four scientific improvements in suture making. It has greater uniformity of gauge and strength, minimizes knot breakage, a Lock-Knot Finish which gives greater security of knots, and Tru-Chromicizing, which controls digestion. Today the Ethicon label is your assurance of the finest quality catgut, the accomplishment of years of research, rigid laboratory control and exclusive manufacturing methods.

Take advantage of these four improvements that aid in locking your knots—specify Ethicon.

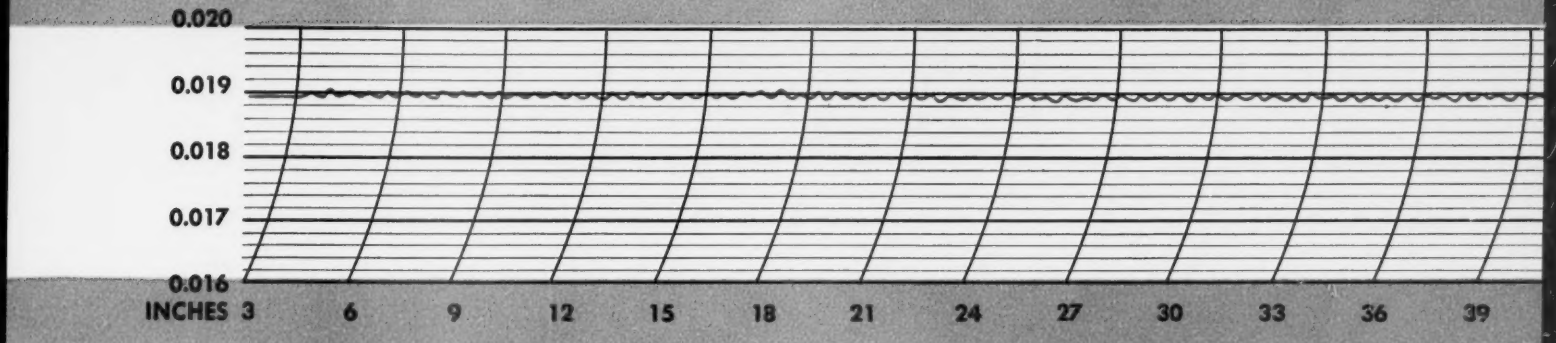
EXCLUSIVE—TRU-CHROMICIZING RESISTS PREMATURE ABSORPTION

Many sutures are chromicized merely on the surface. The chromic coating is easily abraded, exposing untreated catgut, hastening disintegration. Ethicon's exclusive through-and-through chromicizing resists premature absorption.



ORDINARY SUTURE

SIZE 1, charted by the photoelectric microgauge, shows diameter irregularities along entire length of strand.



ETHICON SUTURE

SIZE 1, charted in same manner by the microgauge, shows gauge-uniformity resulting from exclusive Tru-Gauging process. This gauge-uniformity assures greater strength by eliminating "low spots" that cause weakness.

ETHICON

LOCK KNOT

SUTURES

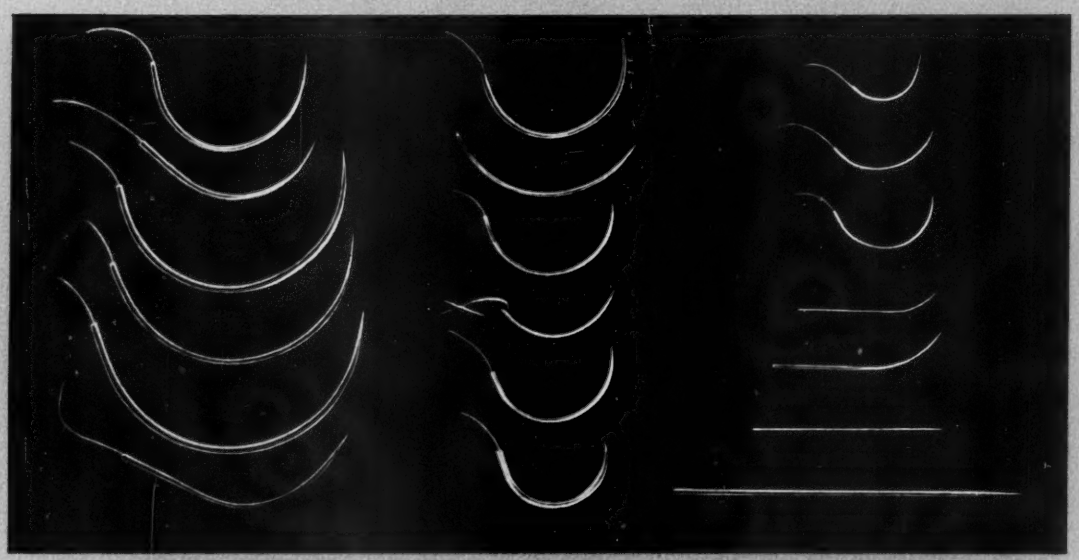
Johnson & Johnson

ETHICON
SUTURES

SUTURES FOR EVERY SURGICAL FIELD

Ethicon Absorbable and Non-Absorbable Sutures are supplied in a wide range of materials to meet the needs of every surgical field.

General Surgery	Eye Surgery	Plastic Surgery
Gynecology	Dental	Orthopedics
Obstetrics	Ear, Nose, Throat	Oral Surgery
Gastro-Intestinal	Thyroid	Proctology
Urology	Neuro-Surgery	Industrial Surgery



A few of the many Ethicon Needles

The above needles are a few of the many special needles attached to Ethicon Sutures. Supplied with either catgut or non-absorbable material, Ethicon Atraloc Needles (non-traumatic type) are firmly and smoothly swaged to the suture. These needle-suture combinations speed up your work and minimize trauma.

Johnson & Johnson

Ethicon Suture Division
Johnson & Johnson, New Brunswick, N. J.

☐ Please send me the new Ethicon Suture Catalog.

☐ Please have an Ethicon Suture consultant call on me.

*Name*_____

*Address*_____

World's Largest Manufacturer of Surgical Catgut

Suture Laboratories at
New Brunswick, N. J.; Chicago, Ill.;
Brazil; Argentina; England; Australia.

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-second Year of Continuous Publication

NEW SERIES VOL. LXI AUGUST, 1943 NUMBER TWO

Editorial

POSTWAR MEDICAL ECONOMIC PROBLEMS

THE world conflagration is entering a phase in which postwar planning begins to assume an ever greater importance. Our national administration anticipates serious dislocations in the social structure of our country after the victorious conclusion of the war. Plans are being prepared which may absorb the inevitable shock to our well established peace standards. There can be but little doubt, that the worldwide clash of opposing ideologies will eventually lead to profound changes in our present national life. It is of great importance that the medical profession be prepared for the essential rôle it will have to play in the postwar social adjustments.

In the past, organized medicine had as its outstanding achievement the protection of the great public, by establishing and maintaining a high ethical and professional standard in medical care. This accomplishment was made possible by the wholehearted and unselfish co-operation of the entire medical profession.

During the economic stress of the prewar period, however, a large minority of our professional membership began to view with growing apprehension the apparent inability of our medical administration to cope successfully with the grave economic problems that have arisen within the public as well as within our own ranks. In the past decade, our Government embarked on a well planned experimentation to eliminate certain social injustices relating to non-medical fields. The impression, that organized medicine's stand in these critical times was neither forceful nor constructive, was the cause of unrest within our professional body.

At the present time, the medical profession is giving further evidence of unselfish co-operation, by taking its part in the war effort. Medical practices, which were built up with so much sweat and toil, are being voluntarily given up by those who enter the Armed forces.

After the war, due to his prolonged absence from civilian life, the physician returning from the war front is bound to find increasing difficulties when resuming his practice. It is the great responsibility of those, who remained on the home front, to work out a constructive plan which will spare our homecoming medical men from undue hardships. The failure of effective postwar planning now will adversely affect the public health and also our professional standards. Medical care dispensed by weary, disillusioned men, is not likely to be of the high plane to which our public became accustomed in the past, and, on the other hand, an unbearable economic plight among our medical men may easily lead to a deterioration of the high ethical standards of our profession.

In the postwar planning of medical care, due consideration should be given to the economic problems of the medical profession. Up to the present time, in the discussions of adequate medical care to the "underprivileged" classes, not much thought was given to the adequate compensation for our medical services. The community looks upon physicians as being individuals of a prosperous, financially self-sufficient class. The lavish dispensation of free medical services seemingly supports this general assumption. Individual physicians intentionally contribute to this false conception by keeping up outward appearances which do not reflect their true economic status. As a matter of fact, the economic condition of the medical profession underwent a steady deterioration in the past decade, and in a large group it sank below subsistence levels. This group's subsistence largely depends upon the material support given by wives, parents and other close relatives. The end of this process is not yet in sight.

The general public is not aware of the medical profession's economic difficulties. It may expect, therefore, further sacrifices from us in the form of extended free medical services. It is probable that our Government is now preparing a sweeping reform of our present medical care. For such an eventuality, we should be ready with a plan, which gives us full protection with just appreciation of our economic needs.

Unless organized medicine is capable and willing to act constructively now, we are faced with the probability, that after the war, a majority of our professional membership will welcome a government plan of health care as part of the general social security system.

It is regrettable, that an open discussion of our economic problems is not possible, since organized medicine suspended its meetings for the duration of the war. We must, therefore, rely on the vision and wisdom of our medical leaders to bring about a satisfactory solution of our postwar problems. Let us hope, that after the storm of social adjustments has blown over, organized medicine will not have to pride itself with having been the last bastion of dye-hard conservatism in a changing world.

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Original Articles

TECHNIC OF PODALIC VERSION AND EXTRACTION

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JUST as the attitude toward early cesarean section and the avoidance of long drawn out tests of labor has changed, so has the attitude in the past ten years changed toward the use of version and extraction. The profession now believes that the technic of this type of delivery should be part of the armentarium of everyone who professes to practice obstetrics. He at least should have a working knowledge of the fundamental principles and maneuvers involved in this type of mechanism of labor.

The indications for this procedure vary with the individual skill of the operators. Some men elect this method of delivery as a routine method of eliminating the second stage of labor while others reserve this procedure for persistent posterior position of the fetal head, deep transverse arrest of the head, uterine inertia, floating heads, etc. Regardless of the indications certain essential prerequisites must be kept in mind if a successful result for mother and child is to be obtained.

In a recent publication[1] we emphasized the fact that a version and extraction should not be attempted until the lower uterine segment is thinned out and the external os completely dilated. The failure to observe this fundamental fact in any type of vaginal delivery has caused untold calamity.

The diagrams labelled 1 and 2 demonstrate in a schematic way, conditions (Figs. 1, 2 and 3) of the lower uterine segment and external os, which are unfavorable for a version and extraction. It will be noted that in both drawings there is still a remnant of the internal os and that the external os is thick. In other words, the effacement of the lower uterine segment and the dilatation of the external os is not complete and is, therefore, not in an ideal condition for attempted delivery.

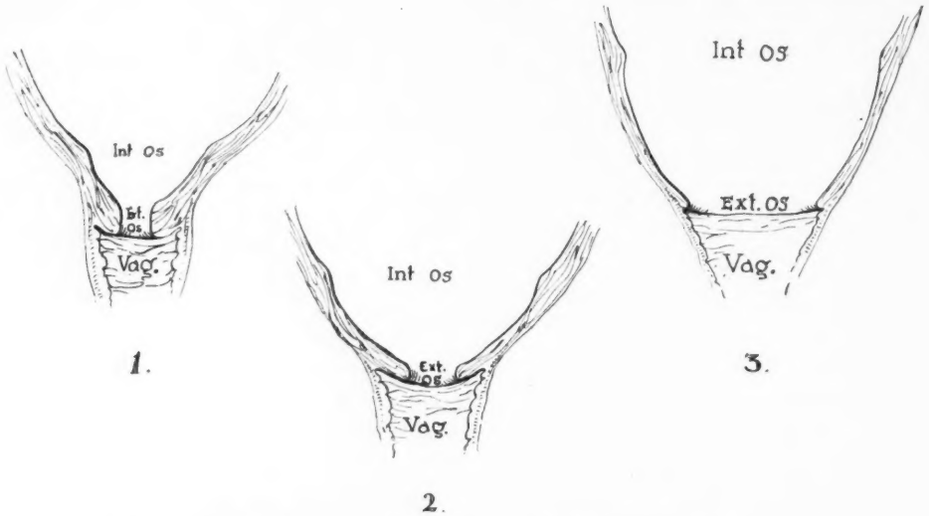
Figure 3 represents the ideal condition of the lower uterine segment and the external os. The lower uterine segment has been thinned out, the internal os has disappeared and the external os is completely dilated. When those conditions are present the ideal time has arrived for the performance of version and extraction.

Another essential fact to be remembered is that a version should never be attempted when the uterus is dry and firmly contracted around the fetus. This condition does not exist as a rule excepting after ruptured membranes and a long labor. The uterus has molded itself around the fetus and a very definite retraction ring is present. (Fig. 4.) Any attempt to perform a version under these circumstances is, to say the least, poor obstetrical judgment and can result only in a ruptured uterus.

A third precautionary fact to be kept in mind is that, while a floating head can be delivered by this procedure, this type of case always carried a greater risk, and the operator must expect a higher fetal mortality rate, as he does with a breech extraction, because, there is no molding of the

head with flexion. We consider at least partial molding of the head with flexion essential.

of the marked depressive effect upon the baby. If any drug is to be used, it should be morphine sulfate in quarter grain doses and



FIGS. 1 TO 3. Various stages of effacement of the lower uterine segment.

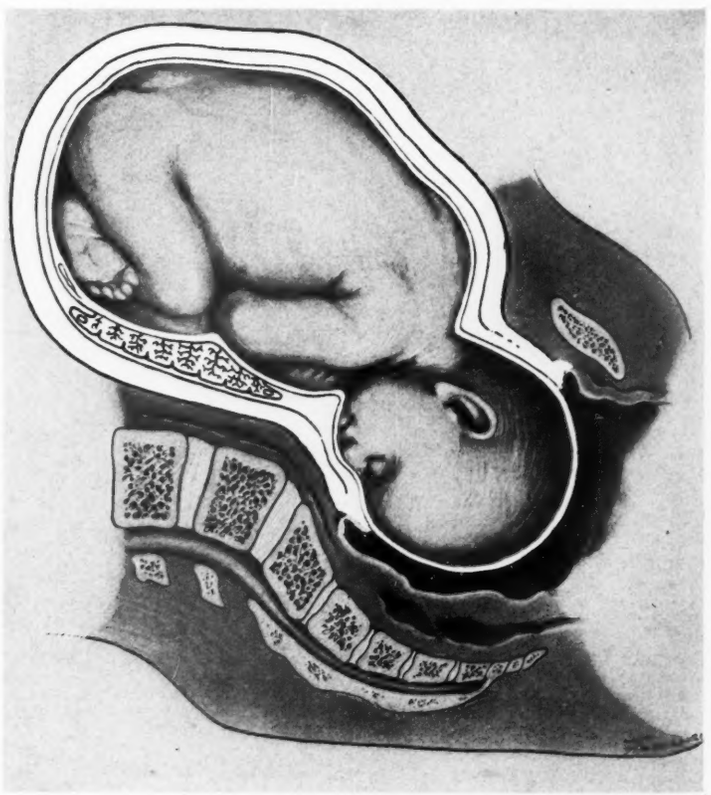


FIG. 4. Uterus completely molded around fetus. Impossible condition for performance of internal podalic version.

It has always been our practice to avoid barbiturates of any kind (recent investigations confirm the deliterious effect of these drugs on the fetus) during labor, because care should be taken not to give it if delivery is to be effected within three hours.

These essential prerequisites are always required before the patient is ready for

delivery by version and extraction: (1) Complete effacement of the lower uterine segment; (2) complete dilatation of the external os; (3) fetal head at or in the brim of the pelvis; (4) membranes unruptured or, if ruptured, the uterus is not too tightly molded about the fetus.

The preparation of the patient consists of cleansing and shaving. No enemas are given because of possible contamination with loose stool.

The patient is draped in the modified Walcher position with nurses holding the legs, and if no assistance is available, the legs can be supported by two chairs whose backs are facing each other.

Chloroform is used as an anesthetic because of its ease of administration and the deep relaxation obtained. Again let us repeat the so-called obstetrical anesthetic has no place in this procedure. The patient must be anesthetized to a surgical degree after which the bladder is emptied by means of a soft rubber catheter.

At this time the vagina is ironed out by the introduction of one finger and finally with the entire hand. The movement is from within out and from above down and is aided by the use of much sterile liquid green soap. When a tight outlet is encountered, twenty minutes is often consumed in this ironing out process. This does away with the need of an episiotomy.

The operator's hand is introduced into the uterus with the palm up in order to more easily follow the curve of the sacrum. The head is grasped like a baseball and is pushed up out of the inlet and iliac fossa.

At this time the position of the head is obtained by paying attention to the ears, which are always on the side of the head and the operator then explores the interior of the uterus and visualizes the exact position of the fetus. It must be remembered, that when the hand and arm, covered with a long rubber glove reaching the elbow, is once introduced into the uterus, it is not withdrawn until the feet are delivered. Repeated introduction of one hand and then the other is to be deplored because of the possibility of infection.

If the membranes are intact they are separated from the uterine wall, care being taken to avoid the side of the placenta, as detachment of the placenta causes bleeding. They are ruptured high up in order to save some of the amniotic fluid which facilitates the version.

The operator next folds the arms across the chest and under the chin. (Fig. 6.) This maneuver prevents extending of the arms, which is a most serious complication. It is surprising how often the arms are not in the usual textbook position of being folded, but many times are along side of the head or body, and any attempt to do a version before they are folded properly will result in extension of one or both arms and we so firmly believe in this statement, that when the operator does get extension of the arms, he has only himself to blame for he either failed to fold the arms or he did it carelessly. (Fig. 5.)

Both feet are now grasped between the first and middle fingers and brought down as far as the iliac fossa. At this time, it is wise to recheck the folding of the arms and having done this, both feet are brought down to the vulva and delivered together. Continued gentle traction is made until the knees are exposed. The version is now complete.

It is essential to take plenty of time during the following extraction, and the sooner the operator forgets the proved fallacy that a baby must be extracted within seven minutes the better results will be obtained.

Delivery of the buttocks is effected through the hollow of the sacrum by simply lifting both feet up toward the ceiling so that the baby is actually sitting on its mother's perineum.

Whether the original position of the fetus was a right or left sided position will depend upon whether the body will rotate to the patient's right or left spontaneously. Some aid may be needed in the rotation of the body by slight pressure on the baby's

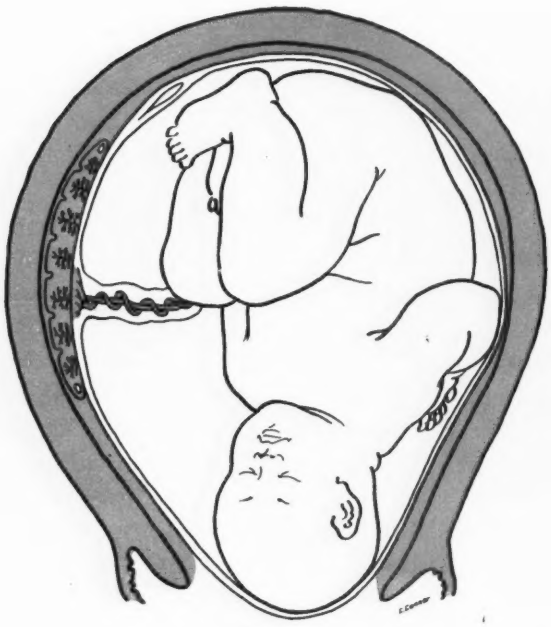


FIG. 5A.

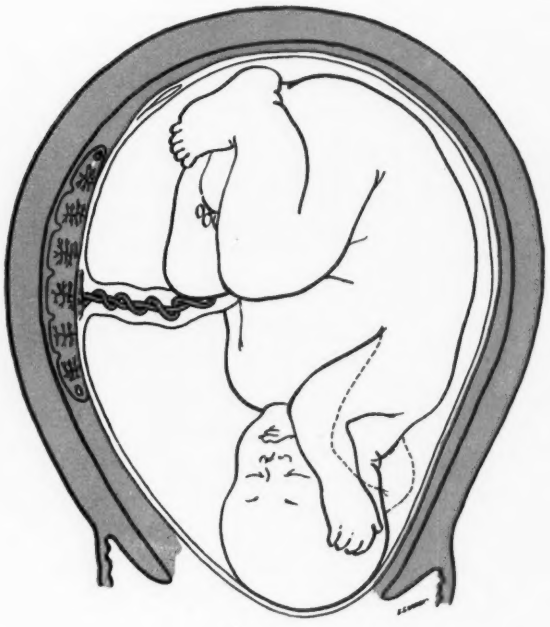


FIG. 5B.

FIG. 5C.

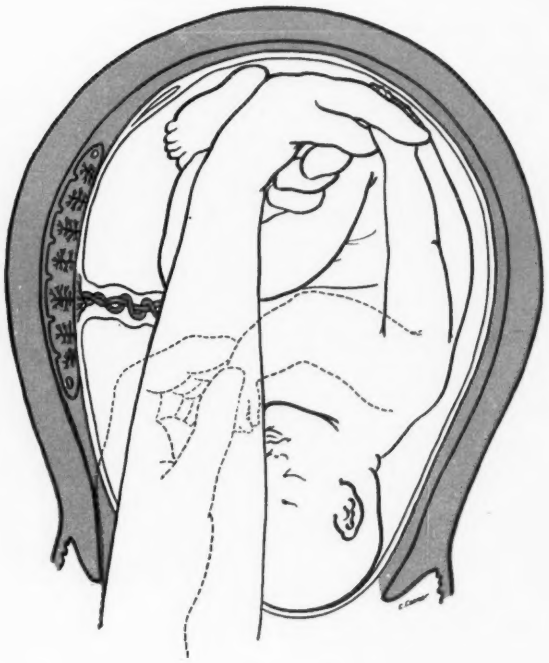


FIG. 5D.

FIG. 5. Frequently found positions of arms in utero which spell disaster if not corrected before attempted podalic version.

thigh. The rotation is completed by traction upon both feet in the direction of the mother's thighs until the scapulae appear. Here the aim of the operator is to get the back straight across underneath the pubic arch so as to facilitate delivery of the shoulders and arms as anterior shoulders and arms, doing away entirely with delivery of posterior shoulders and arms. This is accomplished by placing a finger at the angle of either one of the thoroughly exposed scapulae, and with slight pressure toward the midline, deliver the shoulder and humerus. With the finger in the bend of the elbow and avoiding the hooking of a finger around the humerus, the arm is lifted up and delivered in a manner similar to the lifting up of an old fashioned pump handle.

A finger at the angle of the other scapula, after the body has been rotated will convert the posterior shoulder into an anterior one and the extraction is effected as already mentioned. It must be remembered that at no time is the body twisted, but instead by equal traction on both feet, the body will rotate spontaneously.

The operator now determines if there is any loop of cord around the neck or between the legs of the child and if present, this must be eased by cutting it, if necessary.

The fingers of the left hand are placed on the baby's chin or in the mouth and with the right hand gentle pressure is made on the occiput over the pubes, to aid in the flexion of the baby's head and also direct its passage through the pelvic canal.

If difficulty is encountered, forceps, preferably Pipers, are applied to the sides of the head, care being taken not to make application when the head is high in the pelvis. It should be remembered, that it is easier and safer to push a head through the pelvis than to pull it through. (Fig. 9.) When the after-coming head has reached the perineum and the mouth is exposed, the mucous is milked out of the baby's throat and the head gently eased out and lifted up over the perineal body as a flexed head. The patient must be thoroughly relaxed in the Walcher position to avoid lacerations.

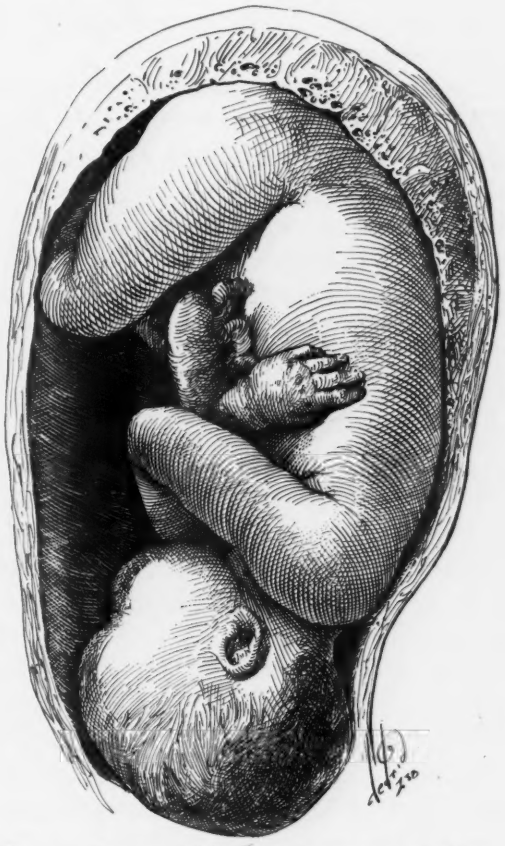


Fig. 6. Proper folding of arms across chest and under chin before attempting internal podalic version.

The baby is placed on its right side on the mother's abdomen, the cord cut, an umbilical clamp applied and the baby transferred to a warm crib.

Following delivery of the placenta, a cubic centimeter of pitocin is given intravenously, the cervix examined and repaired if necessary, the bladder again catheterized and the patient is returned to her room.

COMMENTS

There has been a great deal of discussion concerning the ability of the average general practitioner to carry out this technic. We believe, as we mentioned in the introduction, everyone should know the funda-

mental principles of this type of delivery. We do not believe everyone should try this procedure, but anyone who has had surgical training along with obstetrical training should be qualified to carry out this procedure successfully.

This is not a hospital procedure *per se* as the technic can be carried out in the home with equally good results, as we have often demonstrated.

In our experience in properly selected cases, the fetal and maternal morbidity and mortality is no greater than in other methods of delivery.

This brings up the question of anesthesia. We are firm believers in chloroform properly administered by a competent man, and it behooves any person delivering women to team up with a competent anesthetist at the head of the table. We like chloroform because it is least harmful to the baby, because of its ease of administration, the complete relaxation obtained and the quick recovery of the patient. It must be remembered that the mask must always be the width of two fingers from the face of the patient, and that it takes approximately eight minutes to get a patient in the state of deep surgical anesthesia. The chloroform is not poured but is administered by drops, remembering not to hold the bottle too far from the mask. Fifty per cent of the operator's battle is won at the onset if he has an understanding, co-operative, trained anesthetist. Complete deep anesthesia is needed at only two stages of the procedure, first while the hand and arm are in the uterus, and second, at the time the after-coming head is being lifted off the perineum.

We believe that many lacerations of the perineum are the result of decreasing the anesthesia at this point and the operator's forgetfulness to maintain flexion of the head and pulling the head through the perineal body rather than lifting it up off the perineum.

We have spoken at some length concerning the effacement of the lower uterine segment and dilatation of the external os because we still find much misunderstanding concerning the proper time to perform this type of delivery. Our discussion on this point is as clear as we are capable of making it. There are, however, isolated cases which require further explanation.

In consultation we frequently see arrest of the head in the midpelvis. The lower uterine segment is effaced, but the head, which is in the transverse or posterior position is above the external os which is perhaps three fingers dilated and will never become more dilated, because of the absence of the head as a dilator at the external os, which is paralyzed, and will become swollen and edematous if delivery is not effected at once. It is surprising how easily under deep anesthesia the external os, represented as a thin negotiable rim, disappears when the examining fingers are spread apart and allows the entrance of the hand into the uterus. As we have stated elsewhere,[1] the crux of the situation is the complete effacement of the lower uterine segment, and dilatation of the external os is one of degree only.

It must also be kept in mind, that the formation of a uterine retraction ring commences at the onset of labor, and that at the beginning of the second stage when the lower uterine segment is completely effaced and the external os completely dilated, the retraction ring is well developed and the longer the second stage the more pronounced is the retraction ring. For this reason alone, we believe that the present tendency of attempting to perform this type of delivery, as a last resort, is a mistake. If this method of delivery is to be used at all it should be used at the proper time, and not wait until the uterus is molded tightly about the fetus. We also believe that the use of bags or pituitrin in the first stage of labor is contraindicated, because bags are prone to displace the presenting part allowing a prolapse of the cord and a possible detachment of the

placenta causing death of the child. Pituitrin likewise causes fetal mortality by producing uncontrollable uterine contractions.

Regarding the use of antiseptics our experience leads us to the conclusion that soap and water generously used meet all the requirements necessary.

We also believe that the proper ironing out of a birth canal before the introduction of a hand is most important, and this procedure, if done properly and carefully, makes episiotomy unnecessary. The argument put forth that the fascia beneath the vaginal mucosa is separated is greatly exaggerated.

It is important at this time to again emphasize that haste in the extraction of the fetus is not only unnecessary but harmful, because of the damage liable to occur to the soft parts of the mother and the loss of flexion, which is so essential in the proper extraction of the fetus. It has often taken us as long as twenty minutes to complete the delivery of the child after the navel has appeared at the vulva.

It is allowable at all times to make gentle, steady traction upon the child as long as the child moves through the birth canal. When the child does not move careful examination to determine the cause must be made. The most frequent obstruction encountered is the umbilical cord between the legs. This should be cut to allow the continuous passage of the child and a hemostat is applied to the cut cord as it appears at the vulva.

Another cause of delayed descent of the child is a prolapsed arm. When this occurs no attempt at replacement of the arm should be made but as the fingers of the child appear at the vulva, the operator grasps the fingers with a piece of gauze making gentle traction and delivering the hand and arm along side the body of the child.

We never cover the body of the child during the extraction with a warm towel and neither do we twist or grasp the body during extraction because of possible injury to the internal organs. Much more satisfactory traction is obtained and along with it spontaneous rotation of the body if traction is made upon the feet by grasping them between the first and middle fingers. No slipping is possible if pressure is made upon the index finger by the thumb. It should also be remembered that rotation of the back is aided many times by greater traction on the anterior leg.

The delivery of both shoulders as anterior shoulders, we believe, is a decided improvement in the technic, because we more easily avoid perineal tears and are less prone to get infections because of possible contact with the rectum.

As a practical point we have noticed that since the intravenous use of pitocin immediately following the third stage of labor, the blood loss has been reduced materially and it is a good procedure regardless of the type of delivery.

We are also of the opinion that at all times the birth canal should be carefully examined and the necessary repairs made immediately following delivery, whether it is in the home or in the hospital. Immediate repairs of cervical injuries tend to aid involution of the uterus and at the same time, it is possible to remove old scar tissue and infected cervical cysts in multiparae, but care should be exercised not to remove too much tissue.

Comment was made in 1928 by the senior author to the effect that unilateral tears appear on the side of the cervix where the occiput has remained the longest. For example, in prolonged left occiput posterior positions it would appear on the left side and right occiput posterior positions on the right side, thus emphasizing the damage from prolonged posterior positions. Since making that observation we have seen no reason for changing our opinion.

Resuscitation of the child, when necessary, is accomplished by treating the child as a patient in shock. Dry external heat is applied by warm towels, mucus is aspirated from the trachia by means of a small rubber catheter and air is introduced directly into

the lungs by blowing into the catheter gently and expelling the same by gentle pressure on the chest of the child. The heart beat and the color of the child are the indicators of its condition, and if the heart beat is present the resuscitation is usually successful. We have for years discarded the procedure of the so-called tubbing and spanking of the child, as being entirely out of place in the treatment of a shocked patient.

SUMMARY

An attempt has been made to simplify, clarify and standardize the technic of podalic version and extraction.

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The symptoms of carcinoma of the ovary in the earlier stages are those of any other solid ovarian tumor and are usually absent until rupture of the capsule has occurred, when recurrent pain, ascites, and cachexia make their appearance.

From "Essentials of Gynecology" by Willard R. Cooke (J. B. Lippincott Company).

KINETIC DISABILITIES OF THE HAND AND THEIR CLASSIFICATION*

A STUDY IN BALANCE AND IMBALANCE OF THE HAND MUSCLES

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THE normal hand is kinetically balanced. The muscles, serving *common* flexion and extension, which begin in the forearm and end by tendon in the hand, are the *extrinsic muscles*. The muscles, arising and ending in the hand are *intrinsic muscles*, of which there are five groups: the thenar grouping, the adductors of the thumb, the hypothenar grouping, the lumbrical muscles and the interossei muscles.

The examination of the hand is made systematically. Common flexor power is set against common extensor power, extrinsic power against intrinsic power, and intrinsic power against intrinsic power. The normal hand is easily known; the kinetically imbalanced hand needs detailed study.

This is a study of the hand whose function is changed by *paralysis, contracture* or *muscular imbalance*. It excludes infections of the hand, fractures, many forms of trauma, and tumors of the hand.

The problem is simplified by dividing hand disability into four groups: *the kinetic disabilities of the spastic hand, the arthritic hand, the paralytic hand,* and *the traumatized hand.* Each muscle grouping is analyzed in each of these four divisions of disability.

Finger Rebound Phenomena. When either the flexor or extensor mechanism of a finger is passively tensed, finger rebound takes place on sudden release of tension. Two rebound phenomena are normal and constant.

Extensor Rebound. If the finger is extended actively at its three joints, release of the passively flexed end phalanx snaps this phalanx back into extension. This *extensor rebound* is also seen in the intrinsic position of the finger and is strong even in palmar flexion of wrist. Passive flexion of the end phalanx tenses the extensor mechanism and release of tensing flexion causes rebound of the phalanx into extension.

The extensor rebound is the rebound of intrinsic extension and not of the whole extensor apparatus of a finger, except when the finger is on a line with its metacarpal. This is made clear in radial nerve palsy. The end and middle phalanges extend actively and there is a good extensor rebound; it is not possible to extend the proximal phalanges. In ulnar nerve palsy, there is no extensor rebound, although the common extensor tendons are strong.

Flexor Rebound. The flexor rebound is a confirmatory test of flexor profundus power of a finger. The finger, being actively hyperextended at the metacarpophalangeal joint and hence flexed at its two distal joints, snaps back into flexion on release of passive extension of the end phalanx. Flexor sublimis rebound is not striking.

Increasing flexion of the proximal joint increases flexion of the distal joint and hence flexor rebound of the distal phalanx. Flexor rebound lessens as flexion of the distal joint decreases. Rebound is lessened in extreme palmar flexion of the wrist except in hyperextension of the metacarpophalangeal joint with associated finger flexion. It is weak in acute metacarpophalangeal joint flexion and disappears when the metacarpophalangeal joint is placed between 165° and 180°, with accom-

* From the Hospital for Joint Diseases, New York City, the services of Dr. Leo Mayer and Dr. Harry D. Sonnenschein.

panying slight flexion of the interphalangeal joints. This is a narrow field of tension equality in which extensor or flexor rebound

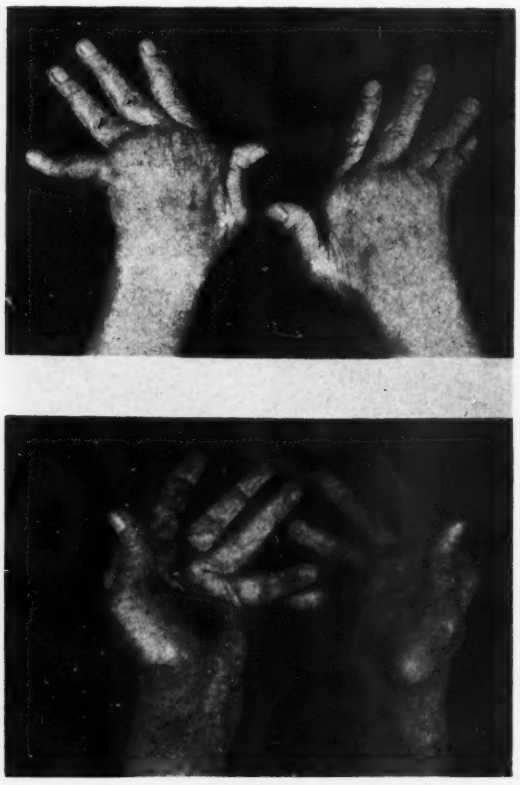


Fig. 1. The intrinsic deformity of the thumb in an arthritic hand. The ulnarly deviated fingers are also held in the intrinsic position.

is absent. If balance between flexor and extensor strength is broken, a rebound may take place in the neutral field.

The *abnormal rebounds* indicate a state of increased tension in one or more of the muscles controlling the finger.

Common Extensor Rebound. In two cases of absent flexor tendon function a *common extensor rebound* was seen. When the finger was passively flexed at its proximal joint, release of pressure snapped the finger back into extension by common extensor action.

A *whole finger extensor rebound* is rarely seen in the spastic hand whose three phalangeal joints are in extension. Release of passive flexion of the finger at the metacarpophalangeal joint snaps it back into extension. It was also seen once in a hand whose ulnar bursa had been infected.

Flexor Sublimis Rebound. The flexor sublimis rebound is indicative of increased tension in the sublimis muscle of a finger. It is seen in long maintained flexion position of the proximal joint of a finger, as in ulnar nerve palsy. When the finger is passively extended at this joint, release snaps the finger back into flexion.

Interosseous Rebounds. These may be divided into two groups: the *lateral interosseous rebound* and the *flexor interosseous rebound* or *whole finger rebound.*

The *lateral interosseous rebound* is due to an increased state of tension of one interosseous muscle of a finger over its balancing interosseous muscle. This is tested when the finger is passively held in intrinsic position in lateral deviation *opposite* to the action of the stronger interosseous muscle tested and then released. (A *lateral extensor rebound* of the finger at the metacarpophalangeal joint by common extensor action is differentiated from the lateral interosseous rebound because the former is tested in extension of the metacarpophalangeal joint. A particular form of this rebound is that of the little finger in extension-abduction position, which, when brought to the ring finger, rebounds to its pristine position on release.) The *flexor interosseous rebound* indicates a state of tension in the interossei of a finger greater than common extensor tension. The sum effect is to maintain the finger in intrinsic position *without* lateral deviation. The rebound is tested by bringing the finger passively into extension at the metacarpophalangeal joint, the end phalanges remaining extended. The finger snaps back into the intrinsic position on release. The same rebound is seen in the thumb, when the flexor brevis pollicis has a tension greater than that of the extensor brevis pollicis. Since the whole thumb is snapped back, the phenomenon may be called a *whole thumb rebound,* since it corresponds to a whole finger rebound.

Given two balancing muscles which are not structurally shortened, *the strength of one over the other* is tested by the in-

creased tension state of the stronger. This increased tension made possible by muscle contraction, is recognized by the rebound which takes place on release of the tension force. This belief presupposes a direct relation between muscle tension and muscle strength which may not always be true. The increased tension of a spastic muscle does not necessarily bespeak its greater *absolute* strength, but if its rebound exceeds its balancing antagonist, it has relatively greater strength than its opponent muscle. Probably the purest value of the rebound is seen in the paralytic hand. The paralyzed muscle cannot tense nor contract while its active antagonist can do so.

When a muscle is structurally shortened as in arthritic (myositic) contracture, its increased tension state does not mean increased absolute strength. Its range of motion is less and so must be its power. But it is relatively stronger than its antagonist if its testing rebound is greater.

The rebound phenomena hence only test *relative* strengths of balancing muscles. This is their significant clinical use.

KINETIC DISABILITIES OF THE THENAR MUSCLES—THE INTRINSIC DEFORMITY OF THE THUMB—THE SEQUEL OF RECURRENT ULNAR LUXATION OF THE EXTENSOR LONGUS POLLICIS

This is a not uncommon deformity of the thumb and is like the intrinsic deformity of the finger. The thumb is flexed at the metacarpophalangeal joint and extended or hyperextended at the interphalangeal joint. The first metacarpal bone is either in opposition position or in abduction.

Flexion of the metacarpophalangeal joint is by pull of the flexor brevis pollicis. Extension or hyperextension of the interphalangeal joint takes place as a synergistic movement as the thumb is flexed at its metacarpophalangeal joint by pull of the fascial band which passes to the dorsum of the second phalanx from the abductor brevis pollicis, or by pull of the extensor longus pollicis, or a combination of these factors. In time, the deformity becomes fixed.

The deformity is caused by the imbalance between a weak or absent extensor brevis pollicis and a strong flexor brevis pollicis. The flexor longus pollicis plays a secondary part, for the intrinsic deformity may develop when long flexor action is absent. In one case, an intrinsic deformity of the thumb followed section of the flexor longus pollicis distal to the insertion of the flexor brevis pollicis.

Weakness of the flexor longus pollicis is usually more apparent than real. The end phalanx of the thumb may not be flexed actively more than a few degrees in the intrinsic position of the thumb. When the thumb is passively extended at the metacarpophalangeal joint, active flexion of the end phalanx may become full and strong. The flexor longus pollicis may, however, be secondarily weakened by persistent hyperextension of the end phalanx.

The intrinsic deformity is seen in three of the four principal groupings of hand disabilities: the traumatic, the spastic, and especially, the arthritic hand. It is rarely seen in the paralytic hand, since the thenar muscles of which the flexor brevis pollicis is a part, are so frequently paralyzed. Mild deformity is sometimes observed in median nerve paralysis, because the ulnar head of the flexor brevis pollicis is supplied by the ulnar nerve. Tear of the extensor brevis pollicis, or strain of or blunt injury to the dorsal capsule of the metacarpophalangeal joint of the thumb (in which the extensor brevis inserts) is followed sooner or later by the isolated development of this deformity, even as early as a month after injury. It is but one of other deformities in the arthritic or spastic hand. In the arthritic hand, it is usually due to arthritis of the metacarpophalangeal joint of the thumb.

The major disability of this deformity is the limitation of flexion of the end phalanx of the thumb. Opposition is possible and may reduce the degree of deformity. The patient may be able to do most types of

work, but yet have difficulty with certain occupations, as typing.

Secondary disabilities may arise, especially after the thumb has become fixed in the position of deformity. The anterior capsule of the metacarpophalangeal joint becomes contracted and, while it may be possible to extend the thumb passively at the metacarpophalangeal joint, release of the thumb snaps it back into flexion (whole thumb flexor rebound). The dorsal capsule of the interphalangeal joint also is contracted. The interphalangeal joint rarely shows secondary destructive arthritis. Recurrent ulnar luxation of the tendon of the extensor longus pollicis is an unusual sequel. This luxation of the tendon is an accentuation of a normal movement—the slight medial and lateral riding of the tendon over the humped dorsum of the metacarpophalangeal joint on flexion and extension of the end phalanx in the intrinsic position of the thumb.

Fig. 2. A, the intrinsic deformity of the right thumb in the case of the girl with recurrent ulnar luxation of the tendon of the extensor longus pollicis. The distal phalanx is in extension but not hyperextension. The left hand shows ulnar deviation of the fingers secondary to arthritis of their metacarpophalangeal joints.

Treatment is usually not necessary. Splinting of the end phalanx in flexion reverses the position of deformity, with some synergistic extension of the first phalanx at the metacarpophalangeal joint. The surgical correction of this disability can be accomplished by the stripping of the thenar muscles. The flexor brevis pollicis must be sectioned fully, as well as the anterior capsule of the metacarpophalangeal joint.

Fig. 2. B, loop retention of the luxating tendon is illustrated in this diagram. The operative technic is described in the text. The loop is so placed that it prevents ulnar luxation of the tendon of the extensor longus pollicis.

INTRINSIC DEFORMITY OF THE THUMB AND RECURRENT MEDIAL OR ULNAR LUXATION OF THE TENDON OF THE EXTENSOR LONGUS POLLICIS

Case 1. Gertrude R., twenty-one, was employed for seven months as a trimmer of scarfs and mufflers in 1934. She made many thousand cutting movements with heavy scissors each day, the scissors reaching to the base of the thumb, making each cutting movement painful. Two weeks after she began this work, her right thumb became swollen, and in another two weeks, she noted "dropping" of the thumb. She also had infectious arthritis of the left hand and wrist.

The right thumb showed an intrinsic deformity, flexion position of 160° being present at its metacarpophalangeal joint. The metacarpophalangeal joint was swollen and painful

dorsally. Tenderness was present along the course of the extensor brevis pollicis. The thumb was held in adduction and she could not abduct it actively. The thumb rested against the index and middle fingers but she could carry it across to the little finger. This inability to abduct the thumb was due to ulnar luxation of the tendon of the extensor longus pollicis. When the end phalanx of the thumb was actively or passively extended, the long extensor tendon slipped radially into place with an audible sound as it passed over the medial tuberosity at the base of the first phalanx. The tendon could also be replaced by passive radial pressure against it. This corrected the intrinsic deformity of the thumb. The thumb could then be abducted and execute a grasping movement. The flexor longus

FIG. 3.

FIG. 4.

FIG. 3. The extrinsic deformity of the thumb in the spastic hand. This is a mutable deformity. There is anterior subluxation of the first metacarpal head by the marked hyperextension position of the metacarpophalangeal joint. The wrist is in neutral position.

FIG. 4. A fixed extrinsic deformity of the left thumb. This man has a combined palsy of the ulnar nerve and posterior interosseous nerve following a bullet wound on September 7, 1938. Suture of the ulnar nerve was done on January 11, 1939, with slight return of power. A wrist fusion was carried out on April 4, 1939. The extension contracture of the middle, ring, and little fingers was released by a Shaw operation early in 1940, and the thumb and index finger were operated upon on June 13, 1940. Capsulotomy of the metacarpophalangeal joint of the thumb with section and stripping of its very thickened collateral ligaments, manipulation of its interphalangeal joint, capsulotomy of the carpometacarpal joint, and adductor section were needed to correct this deformity at the time of operation, an improvement which has not been maintained. On June 5, 1941, tendon transplants were done to give common extension to thumb and fingers. (These operations were done by various surgeons on the Service of Dr. Sonnenschein.) This photograph was taken on December 16, 1939, before attempt at correction.

pollicis, the adductors of the thumb and the thenar muscles seemed normal.

The left wrist was mildly scaphoid over its dorsum. There was mild atrophy of the dorsal interossei muscles. The major disability of the left hand was an ulnar deviation of the fingers at the slightly flexed metacarpophalangeal joints. These joints were somewhat swollen and tender. This arthritic involvement, greatest in the index finger and last in the little finger, caused increased lateral mobility of the metacarpophalangeal joints, both in flexion and extension. It was possible to correct the deformity passively but the ulnar deviation of the fingers was again assumed on release of pressure.

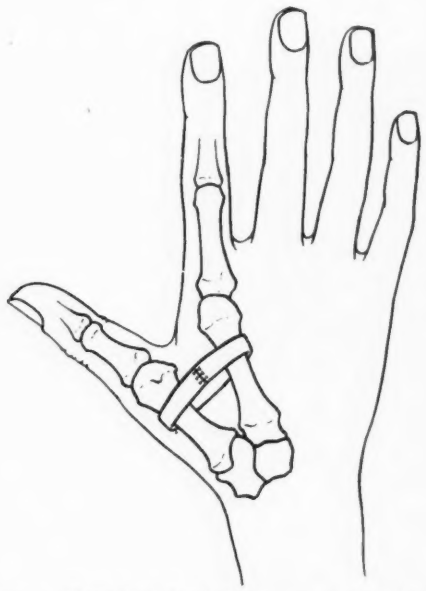


Fig. 5. Sketch of fascial loop operation for athetoid or dystonic opposition of thumb.

The operative procedure—loop retention of the luxated tendon—was advised by Dr. Leo Mayer, and it was on this idea of his that I did the operation on February 12, 1936.

A longitudinal dorso-ulnar incision was made, beginning about three-quarters of an inch above the metacarpophalangeal joint of the thumb and extending proximally along the shaft of the first metacarpal bone. The extensor longus pollicis tendon was identified and its medial displacement verified. The tendon was less shiny than normal and its edges were ragged. The loose and redundant capsule of the metacarpophalangeal joint was edematous, thickened and grayish in color. The periosteum of the first metacarpal bone was thickened and swollen. A tendon loop was made from part of the tendon of the palmaris longus.

In the third stage of the operation, a slightly oblique drill channel was made about one-half inch beneath the head of the first metacarpal, the radial end being a little more proximal. The tendon graft, shaped to fit this channel, was made somewhat thicker at its middle and tapered at each end, care being taken not to injure its gliding surface at the point of contact with the extensor longus pollicis. A Bunnell-Mayer suture of black silk was taken at each end of the tendon. The loop was passed about the extensor tendon so that it pulled it in a radial direction. The tendon ends were directed through the drill channel in the bone by means of a previously introduced guide suture of heavy black silk. The tendon ends, in order that the loop exert a radial pull, went in from the proximal and radial side of the bone to its distal and ulnar side. The tendon ends on the ulnar side of the bone were now brought over dorsally and sutured separately under some tension, to the adjacent tissues radially. It was made sure that the extensor longus pollicis tendon moved freely in the loop. The loop was effective in retaining the tendon in place. After the wound was closed, the thumb was immobilized in abduction and in extension.

The postoperative course was uneventful. She was unco-operative in postoperative treatment.

The ulnar deviation of the fingers of the left hand, quickly overcome by a U-shaped plaster mold which brought the fingers radially, later recurred.

This ulnar deviation is conditioned by position. I was unable to duplicate it by the experimental injection of water into the metacarpophalangeal joints of the hand of a cadaver. Distention by synovial hypertrophy and ligamentous laxity allow postural factors to play an important part, but distention of the joint alone does not reproduce the deformity.

She was seen last in October, 1938. She had worked as a typist for some time but had to discontinue this work because she could not bend the thumb at the interphalangeal joint. The thumb was not swollen. It was held in the intrinsic position, flexed to 90° at the metacarpophalangeal joint, and extended at the interphalangeal joint. The metacarpophalangeal joint could be extended to 100° actively and 180° passively. Release of passive tension

FIG. 6. A, the spastic hand and wrist by extrapyramidal tract lesion. The patient is a man of fifty-six. This photograph was taken on October 16, 1939, and shows an extreme flexion deformity of the wrist in ulnar adduction. The elbow was extended. The fingers were usually in the intrinsic position, but sometimes showed dissociated position or extension at all three phalangeal joints. The intrinsic deformity of the fingers decreased from the little finger to the index finger. The first metacarpal bone was opposed in extension of the metacarpophalangeal and interphalangeal joints. The first metacarpal head was subluxated anteriorly. When he tried to make a fist, there was increase in intrinsic position of the fingers. When the wrist was brought up passively into lesser palmar flexion, the fingers flexed and the thumb went into the palm. When the elbow was bent actively, flexion of the fingers increased and there was greater resistance to passive dorsiflexion of the wrist. The muscles arising from the internal epicondyle of the humerus tensed as the elbow bent and the forearm pronated. B, wedge plasters were applied to bring the wrist into lesser palmar flexion. On April 18, 1940, the internal epicondylar muscles were stripped from their origin and partial neurectomy of the branches of the ulnar and median nerves to these muscles done. It was thereafter possible to bring the wrist into about 20° (160°) of palmar flexion. On August 3, 1940, the tendon of the flexor carpi ulnaris was lengthened and a wedge removed from the wrist joint with dorsal base, the proximal part of the distal carpal bones being removed in this wedge. This is a postoperative photograph taken on November 16, 1940, showing the position of the wrist and fingers after the two-stage operation. Finger power is better.

snapped the thumb back into flexion by elastic rebound due to tightness of the flexor brevis pollicis (a whole thumb flexor rebound). In the intrinsic position of the thumb she could not flex the end phalanx more than five degrees, but, in maintained passive extension of the metacarpophalangeal joint, flexion was almost complete. The strength of the other muscles of the thumb was good. The luxation of the extensor longus pollicis was well corrected.

This injury of the thumb is occupational. No joint of the affected hand was arthritic. The intrinsic deformity of the thumb came first and then the luxation of the tendon; hence, the flexion deformity of the metacarpophalangeal joint of the thumb should have been corrected first, and then the luxation of the tendon.

Case II. In another young woman in her twenties, an excess ulnar movement of the right extensor longus pollicis tendon was present on flexion of the end phalanx. This disability was occupational. She folded large (8″ × 10″) card boards on which metal hair curlers were to be mounted and punched holes in them at the same time. She had done this movement several thousand times a day for four months.

Two months before examination, she had noted a clicking of the tendon of the extensor longus pollicis, as the tendon slipped back and forth. The thumb was splinted for a month and clicking ceased. Since then she had pain on the radial side of the hand and forearm, due to a tendovaginitis of the sheath of the short extensor and long abductor of the thumb.

The thumb did *not* show the intrinsic position. The ulnar mobility of the tendon of the extensor longus pollicis was abnormal, in that it exceeded by far the mobility of the same tendon of the left hand. The subluxating tendon did not click. The thumb was held somewhat abducted and flexed at both its joints as the tendon moved ulnarly; extension of the thumb was restored at its original position. Opposition of the thumb was limited, as were wrist motions.

In this occupational injury it was necessary for the thumb to assume the intrinsic position repeatedly during the day's work. Secondary luxation of the extensor longus pollicis followed, even though the thumb did not remain permanently in the intrinsic position.

EXTRINSIC DISABILITIES OF THE THUMB

Certain extrinsic disabilities of the thumb are described, the most interesting of which is the extrinsic deformity of the thumb. The usual disabilities, stenosing tendovaginitis of the sheath of the flexor pollicis, DeQuervain's stenosing tendovaginitis at the wrist, tendon lacerations of the thumb and their repair, are not discussed here.

EXTRINSIC DEFORMITY OF THE THUMB

In the extrinsic deformity of the thumb, there is extension or hyperextension of its metacarpophalangeal joint and flexion of the interphalangeal joint. The degree of end phalanx flexion (sometimes 90°) influences and is usually much greater than the degree of metacarpophalangeal joint extension. There may even be anterior subluxation of the first metacarpal head. It is more probable that the deformity will develop in greater end phalanx flexion than in lesser. The first metacarpal bone is more often in abduction than in opposition.

When the thumb is abducted in the plane of the hand, there is associated extension of both its metacarpophalangeal and interphalangeal joints. The extensor longus pollicis tendon moves radially and does not stand out as a tight cord. If the distal joint of the thumb is now flexed, the metacarpophalangeal joint being extended (the extrinsic position), the degree of abduction of the thumb synchronously lessens and it becomes impossible to abduct the thumb beyond this limit by tightness of the tendon of the extensor longus pollicis. This movement is a painful strain movement, especially in the muscle belly of the taut adductors. It is most difficult to execute this position of the thumb in the intrinsic position of the fingers.

It is a less common deformity than the intrinsic deformity of the thumb. It may be voluntarily produced by the normal hand but in an unnatural position of strain.

Passive pressure dorsally on the volar aspect of the proximal phalanx of the thumb puts the thumb into the extrinsic

position, the end or distal phalanx flexing at the same time. When the tip of the thumb is held against the radial side of the

When the flexor longus pollicis bends the end phalanx acutely, and the metacarpophalangeal joint is stabilized, the

A B

FIG. 7. A, a thumb made of a synthetic plastic material. This thumb was made by Dr. Edward Klein and colored by Paul Peck, medical illustrator. B, the stump of the thumb is shown in the illustration on the left. Osteotomy of the base of the first metacarpal of this paralytic thumb to place it in opposition position, and release of flexion contracture of the distal phalanx ended in gangrene of the distal phalanx, the vascular interruption being more probably due to the flexion release. On the right, the artificial thumb is in place. The fairly deep cup of this thumb exerted suction effect so that it required some moderate pull to remove it.

index finger, the thumb may go into the extrinsic position.

The extrinsic deformity is due to imbalance of power between the flexor longus pollicis and the common extensors (usually the extensor longus pollicis) in favor of the former. When the flexor brevis pollicis is weak or paralyzed, the deformity develops more easily; yet it is not a *sine qua non* of the deformity that this intrinsic muscle be weak. It is absolutely necessary that the flexor longus pollicis be either stronger than its opposing extensor, or that its muscle belly be structurally shortened. Yet, there must also be stabilization or fixation of the metacarpophalangeal joint so that it does not flex when the interphalangeal joint flexes. This fixation may develop by various cause, as inability to bend the metacarpophalangeal joint in paralysis of the thenar muscles, arthritic fixation, the habitual resting of the thumb against the index finger, and persistent extension (tension) pull of the extensor brevis pollicis. The deformity is favored by dorsiflexion of the wrist, especially when it is mutable; it is, however, also seen in fixed palmar flexion of the wrist.

tendons of the extensor brevis and extensor longus pollicis stand out as tight cords, the tension pull of which tends to extend or to increase extension of the metacarpophalangeal joint. Similar tension pull of the extensor tendons is seen in the *extension variant* of the finger deformity. The position of deformity once assumed is maintained by a probable bow string action of the flexor longus pollicis.

The extrinsic deformity of the thumb is a clawing deformity of the thumb but it is not directly comparable with the claw finger caused by paralysis of the intrinsic muscles of the finger. Functionally speaking, the thumb, being two-jointed, does not need the balancing (intrinsic) meehanism of the three-jointed fingers, and hence does not have a lumbrical muscle.

This deformity occurs in all of the four principal groupings of hand disabilities. In the *spastic* hand, it is a mutable deformity, developing only on dorsiflexion of the wrist. The thumb is either in or out of the palm in palmar flexion; as the wrist is dorsiflexed, the shortened flexor longus pollicis draws the end phalanx of the thumb into marked flexion. The extensor brevis

pollicis tendon becomes taut and its tension pulls the metacarpophalangeal joint into extension. Mutability of this deformity

FIG. 8. A, strap used in a case of median nerve palsy. The nerve had been severed at the wrist by glass and an end-to-end suture done after resection of the neuroma.

means lack of contracture of the metacarpophalangeal joint. Occasionally, the *athetoid* hand shows the intermittent development of this deformity. The atrophic and spastic hand of *amyotrophic lateral sclerosis* may show an extrinsic deformity of the thumb, and this may be of help in the diagnosis of this malady. The thenar muscles, including the flexor brevis pollicis, are atrophic so that the metacarpophalangeal joint is not bent by their action, this resulting ultimately in fixation of the joint. Given a strong or relatively stronger flexor longus pollicis, the extrinsic deformity follows after fixation of the metacarpophalangeal joint.

The deformity is not usually seen in the *poliomyelitic hand.* I observed it once. The thenar muscles were atrophic, the long flexor of the thumb short, and the extensor longus pollicis paralyzed, the wrist being held in slight dorsiflexion. There was definite restriction of motion of the metacarpophalangeal joint of the thumb and fixation of this joint helped create the extrinsic deformity.

The extrinsic deformity may sometimes be seen in the peripheral nerve palsies. Yet, neither median nerve nor ulnar nor radial nerve predominance creates this deformity. In ulnar nerve palsy, however, the thumb may show a mutable extrinsic deformity during substitutionary adduction action of the extensor longus pollicis. The deformity was seen in a man whose hand was paralyzed by a *combined ulnar nerve and posterior interosseous nerve* palsy. The thumb rested against the radial side of the flexed index finger. The deformity may also have been due to poor splinting of the hand. The extrinsic deformity was observed in the paralytic thumb (ulnar and median nerve paralysis) after a Bunnell operation as a transient phase of movement as the thumb was brought across the palm. It was also noted in a man with a combined ulnar and (partial) median nerve palsy, in whom the thumb went into extrinsic position as he brought it forward in intrinsic abduction.

The *arthritic* hand will show this deformity only if there is *arthritis of the interphalangeal joint of the thumb,* even in palmar flexion of the wrist. This joint is not ordinarily involved in rheumatoid arthritis. The resultant flexion deformity of the end phalanx secondarily extends or hyperextends the metacarpophalangeal joint; if the arthritic wrist is flexed palmarly, pull of the stretched extensor brevis pollicis will hyperextend this joint, too.

The extrinsic deformity was seen in the osteo-arthritic hand of an elderly woman, the dorsum of whose metacarpophalangeal joint of the thumb showed moderately sized Heberden's nodes.

The deformity may sometimes develop as a mutable thing when the extensor longus pollicis is injured at the level of the metacarpophalangeal joint; it is present

in dorsiflexion but not in palmar flexion of the wrist.

The extrinsic deformity is then either a fixed, since this is the principal element of deformity. This should be combined with capsulotomy as indicated.

Fig. 8. B, leather strap holding the dystonic thumb abducted.

local thing or part of a complex hand deformity. When deformity is fixed, it may be associated with adduction or pseudo-adduction contracture of the thumb, the position in which the thumb is maintained favoring this other deformity.

This deformity should be prevented by splinting the thumb in a neutral position. If the deformity is mutable, the *treatment* of choice depends on the underlying condition—freeing or suture of the torn extensor longus pollicis or the placing of the spastic hand in a neutral field.

The arthritic interphalangeal joint should be splinted in extension, the wrist being held in slight dorsiflexion.

Operative release of the fixed deformity may be necessary. In only one case was release done—the case of the man with combined ulnar nerve and posterior interosseous nerve palsy. Capsulotomy of the metacarpophalangeal joint of the thumb, including section of the very hypertrophic collateral ligaments, capsulotomy of the carpometacarpal joint, manipulation of the interphalangeal joint into extension, and section of the tight adductors gave fairly good immediate correction of the deformity but lesser ultimate improvement.

The flexor longus pollicis should be lengthened in the wrist, if the deformity is

Proper postoperative splinting and physiotherapy is necessary.

SNAPPING OF THE TENDON OF THE EXTENSOR LONGUS POLLICIS

Case III. A man of thirty voluntarily luxated and snapped his left extensor longus pollicis. This tendon rode over a small bony prominence at the base of the first metacarpal.

When the wrist was flexed palmarly in a little ulnar adduction, the thumb was held in opposition of the first metacarpal bone, in extension at the metacarpophalangeal joint and hyperextension at the interphalangeal joint. The tendon rode with a loud thud over this bony prominence as the thumb was moved. He was able to do the same thing when the wrist was moved, and the thumb held fixed to the fingers in opposition and extension as noted.

This snapping (acquired in childhood), was possible only in one hand. Repetition of luxation was painful.

This luxation is uncommon; it is different from the recurrent luxation associated with the intrinsic deformity of the thumb.

LUXATION OF THE TENDONS OF THE ABDUCTOR LONGUS POLLICIS AND EXTENSOR BREVIS POLLICIS AT THE WRIST

This is a most unusual luxation, only two cases of which have been recorded.

In Goddu's case,[1] a woman complained of disability of the hand which had followed a recent trauma to the right wrist. The thumb gave way so that she dropped things. The pain was localized to the region of the lower end of the radius and base of the thumb. There was a marked laxity of the joint between the first metacarpal bone and the greater multangular. At times, a distinct snapping of the thumb was heard as the thumb was abducted because of luxation of the tendon of the extensor brevis pollicis out of its groove.

The luxation of the short extensor of the thumb seemed to be due to shallowness of the groove in which it rested. This groove was deepened so that the tendon was not injured. A fusion of the first carpometacarpal joint was done. The follow-up was more than two years. The result was good.

A case similar to Goddu's is mentioned in the "Queries and Minor Notes" of the Journal of the American Medical Association.[2]

On hyperextension of the thumb, the extensor pollicis brevis tendon slipped dorsally over the edge of the radius. It was easily replaced but luxation was painful. A fascial loop operation was recommended to keep the tendon in place.

FIG. 9. This is the right hand of a Spanish Loyalist Veteran, who had ankylosis of elbow and wrist after an infection of the forearm by a bullet wound. The adductor contracture of the thumb seemed due to improper splinting. On December 7, 1938, adductor section and wrist fusion were done. Later, he had a resection of the elbow. This photograph, taken October 10, 1939, shows comparative spread of each thumb and the mild volar rotation of the right thumb. This rotation is a sequel of adductor section.

CASE IV. Pauline C., twenty-one years old, complained of pain on the radial side of the left wrist for six months. There was no gross trauma. Pain was of variable intensity. Turning the wrist as in wringing clothes increased pain. She had heard clicking or snapping of the wrist radially and this caused radiation of pain up the forearm.

Motions of the wrist were good except that ulnar adduction was 10° less than normal. On ulnar adduction and slight dorsiflexion of the wrist, subluxation of the extensor brevis pollicis took place, the point of luxation being about ¾ of an inch above the radial styloid. Crepitation was also felt on this maneuver at the site of luxation. Snapping had also been noted when the thumb was manipulated ulnarly. Thumb movements were normal.

A diagnosis of luxation of the extensor brevis pollicis at the wrist was made. No treatment was given.

SPASTIC THUMB

The spastic thumb (and this includes the dystonic and athetoid thumb[3]) is drawn into the palm by spasm of the thenar muscles and flexor longus pollicis

and held there by the overlying flexed fingers, especially in the position of palmar flexion of the wrist. In dorsiflexion, the thumb is often drawn out of the palm. Usually, the first metacarpal bone is inwardly rotated in opposition when the thumb is indrawn, but sometimes it is in external rotation or abduction in dissociated action. The irregular alternation of hyperinnervational impulse in the athetoid hand leads to frequent positional change of the thumb, during which the thumb may assume the intrinsic position, dissociated position, and opposition position. Common extensor action may subluxate the first metacarpal head volarly, especially after thenar muscle stripping or lengthening of the flexor longus pollicis. It is, therefore, more likely that the spastic thumb, whose level of hyperinnervation is more or less constantly maintained, will show contracture in any of these positions.

The operation of thenar stripping,[18] with or without the lengthening of the flexor longus pollicis, has been described for the relief of opposition position or contracture of the thumb.*

This procedure is most likely to succeed in the spastic hand rather than in the athetoid or dystonic hand. One spastic patient was examined three and one-half years after operation and the thumb was still held out of the palm.

Since the procedure did not prove satisfactory in the athetoid, dystonic, or spastic hand with irregularly and frequently alternating spasticity, a fascial loop operation, in addition to the stripping of the thenar muscles, was tried in two patients, one a girl with dystonic hemiplegia, and the other a boy with widespread spasticity. A fascial loop or sling was passed between the first and second metacarpal bones, the thumb being held in full abduction in the plane of the hand. The loop was expected to restrain opposition since it is from the useful position of abduction of the thumb in which opposition is most easily begun. This constant restraint was also expected to diminish thenar muscle spasm. A similar operation has been described by Henschen,[4] who reported a good result in one case.

Ultimately, both operations were failures, although at first the loop did seem to check opposition. There was no thinning of the shafts of the metacarpals in one patient whose hand was roentgenographed more than a year after the operation.

Tenodesis of the extensor brevis pollicis and abductor longus pollicis was tried experimentally, the tendons being fixed into the radius. Such a procedure is feasible only if these muscles are paralyzed. Fascial tenodesis was also studied.

NEUTRAL FIELD OF THE SPASTIC HAND

When the wrist is flexed palmarly, the fingers are held slightly flexed at the three phalangeal joints. If active muscle power is present, the fingers can be more easily extended than flexed in this position. When the wrist is brought into full dorsiflexion, the fingers are held flexed, especially at the proximal and distal interphalangeal joints and it is easier to bend the fingers than to extend them. As the wrist is gradually brought up into dorsiflexion, a position of the wrist in slight dorsiflexion, less than that in which the paralytic or non-spastic wrist is fused, is found in which flexor and extensor finger mobility and strength become fairly equal. This represents the neutral field of action.

The determination of the neutral field demands a freely movable wrist, either passively or actively. The field can not

* The incision used for thenar stripping may be used for infection of the radial bursa as an analogue of Henry's incision. In the experimental hand, the incision is adequate both for drainage of the thenar space and radial bursa. The incision avoids the digital nerves and the motor branch of the median nerve, since the thenar muscles are stripped subperiosteally from the first metacarpal bone. The flexor longus pollicis tendon lies midway between the first and second metacarpal bones, and about 1½ inches of it are seen. If the insertion of the thenar muscles is sectioned, more of the tendon can be examined.

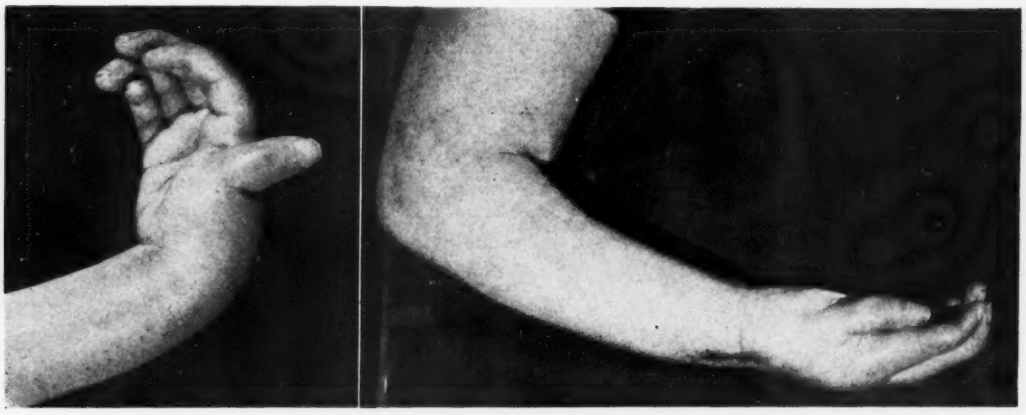
A hemostat passed through the usual web incision for thenar space infections enters into the area exposed by this incision.

be measured if the wrist is fixed in palmar flexion contracture.

A wrist fixed in palmar flexion contracture is influenced by the shortening of the muscles arising from the internal epicondyle of the humerus, and hence by the position of the elbow. When the elbow is flexed, these muscles become tight and offer increasing resistance to passive dorsiflexion of the wrist, the forearm being pronated. When the elbow is extended, there is lesser resistance to dorsiflexion of the wrist and the forearm is supinated. The stripping of these muscles from the internal epicondyle releases to some degree the fixation of the spastic wrist in palmar flexion, a point which has been made by others.

The use of the spastic hand is then dependent upon an interlocking, kinesiological relationship between finger position, wrist position, and elbow position. Wrist position subserves finger position, and elbow position conditions wrist position.

The significance of this neutral field has been stressed by Pusitz.[5] It is of particular importance if the spastic wrist is to be fused. It should be of comparative and corroborative value in flexor to extensor tendon transplant and in epicondylar stripping, or in short, in any procedure aiming to increase extensor power and lessen flexor power.



A B

FIG. 10. A, the right hand of a female spastic patient of twenty-seven. The right metacarpal bone was fixed volarly in opposition with resultant secondary pseudo-adduction contracture. The thumb presents a most unusual and extreme volar rotation. This preoperative photograph was taken on February 24, 1936. The hand was functionless but operative correction of the deformity of the thumb was done for cosmetic reasons and to permit some passive grasping. B, a postoperative photograph taken November 5, 1936, after stripping of the thenar muscles and capsulotomy of the metacarpophalangeal joint of the thumb. Derotation was not attended by any circulatory embarrassment. This patient was last seen in 1942. There is no active use of the hand or thumb.

PARALYSIS OF THE THENAR MUSCLES

The thenar muscles are not infrequently paralyzed in infantile paralysis, and in median nerve palsy or laceration of its motor branch, with resultant flat hand deformity. The inability to carry the thumb forwardly and across to the little finger is a serious disability.

The first metacarpal bone in the flat hand drops back dorsally so that it lies in the plane of the other fingers, and even behind them. The basal end of the first metacarpal and its articulating greater multangular are carried forward. The posterior capsule of the carpometacarpal joint becomes taut and the anterior capsule relaxed. In time, this contracture may fix the thumb so that it becomes difficult to oppose the thumb passively, as pointed out by Mayer.[6] Or, the joint between the carpal bone and the first metacarpal may be so relaxed that foreshortening of the first metacarpal with anterior displacement of the base of the first metacarpal

may develop, a deformity easily reducible by traction but recurring on extensor action of the thumb.

FIG. 11. The hands of the man with bilateral pollex valgus, more marked on the right side. There is soft tissue swelling over the radial aspect of the metacarpophalangeal joint of the thumb. The thumb is not rotated dorsally. The right hand shows a mild adduction contracture but this is not shown here.

Thenar muscle paralysis is not commonly selective. When the abductor pollicis brevis is paretic, the thumb cannot be brought forwardly. When the opponens pollicis is absent, the thumb can not be rotated. Selective paralysis of the flexor brevis pollicis (as in ulnar nerve palsy) is rarely seen, its loss giving presumptive lessened flexion of the metacarpophalangeal joint. In selective thenar palsy, especially in opponens palsy, the thumb can be brought to the little finger in a pseudo-opposition maneuver, the flexor longus pollicis participating in the movement, if it has good strength.

Before any operative procedure the residual power of the hand is reckoned with regard to possible source of muscle and tendon transplantation.

In any operation, passive opposition must be complete, if active opposition is to be expected. It is always difficult to duplicate the normal action of the thenar muscles, which is a carrying-forward and a carrying-across of the thumb. Not infrequently, only a form of opposition is obtained after operation—pseudo-opposition—in which the thumb is carried to the little finger by an adduction movement anterior to the fingers.

The Steindler[7] and Bunnell[8] operations are most used for the restoration of some degree of opposition action of the thumb. Other operative procedures have been described by Ney,[9] Royle,[10] and others.[11] The Bunnell operation has the widest application, for it utilizes as a motor a flexor of the wrist or finger, which is attached to a free tendon transplant passing through an artificially created tendinous loop for better leverage and alteration of line of pull. The line of pull is made oblique and the free tendon graft is sutured to the region of insertion of the thenar muscles.

The importance of contracture of the dorsal part of the carpometacarpal joint of the thumb is stressed by Mayer. Release of this contracture allows opposition after the Bunnell operation and avoids pseudo-opposition. The most ulnar part of the capsule must be incised to give free passive opposition of the thumb. In one case this part of the capsule and the capsule of the joint between the greater and lesser multangular bones were cut before free passive opposition was allowed. Adduction contracture of the thumb must also be overcome to allow use of the thumb in opposition

after the Bunnell or other tenoplastic procedures. Such contracture was noted in two patients, in one of which good opposition later made for this woman and she used this to hold objects with some satisfaction.

Fusion of the carpometacarpal joint of

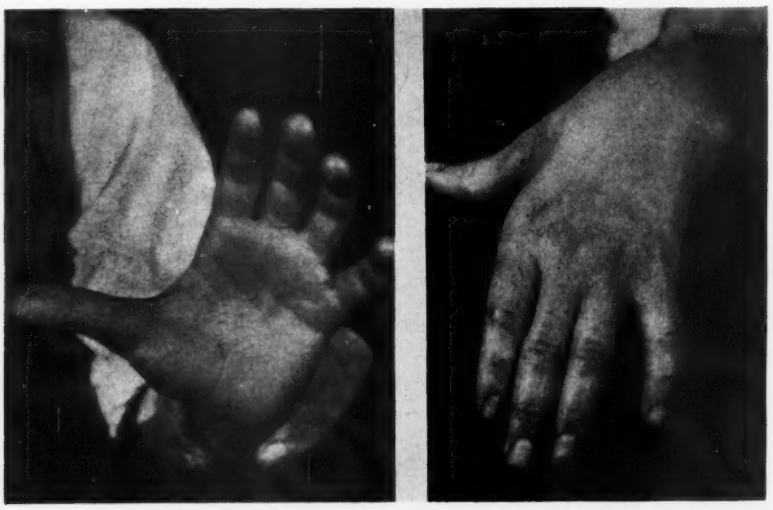


FIG. 12. The left hand of G. S. whose case is reported in detail in the text. The marked atrophy of the first dorsal interosseous space is indicated by its hollowing in the photograph on the right. The contracture in intrinsic ulnar adduction of the index finger and the abduction contracture of the little finger are well shown.

was possible after adductor section. The Steindler operation utilizes the radially split half of the flexor longus pollicis which is transplanted dorsolaterally to the base of the first phalanx of the thumb. It should, however, be noted that a strong long flexor, even when not transplanted, may carry the thumb to the little finger in pseudo-opposition.

Steindler reports acceptable results of this flexor plasty in 92 per cent of twenty-three patients so operated upon.

Silfverskiöld[12] transplanted the whole tendon radially at the level of the metacarpophalangeal joint of the thumb; or, the tendon may be translocated (von Baeyer).

The Steindler operation may create a flexion contracture of the end phalanx of the thumb. Correction of this contracture by z-lengthening of the flexor longus pollicis and anterior capsulotomy of the interphalangeal joint ended in gangrene of the thumb in one case, in which a basal rotational osteotomy of the first metacarpal bone was also done to carry it forward. An artificial thumb of plastic material[13] was

the thumb (Baldwin operation[14]) is an operation the indication for which must be carefully made. The thumb is fused in the position for grasping. The keystone block of Allen and Thompson[15] seems a better way to hold the thumb in a grasping position, a block of bone between the metacarpals of the thumb and index finger holding the thumb rotated.

Rotation osteotomy of the base of the first metacarpal may carry the thumb forward but recurrence seems likely because the kinetic factors producing deformity are not overcome.

Certain experimental operations were worked out for relief of thenar palsy, which have not been tried clinically. They have limited application even theoretically but may be interesting to those who are interested in hand surgery. The author worked with Dr. Charles Sutro on an extra-articular posterior bone block of the carpometacarpal joint of the thumb to prevent the falling back or posterior displacement of the first metacarpal bone. The operative area is small and the bone graft has insecure anchorage. The transference of the

oblique adductor of the thumb to the radial tubercle of the proximal phalanx of the thumb may be of use in median nerve paralysis. In 1937, experiments were made on the transfer of the flexor sublimis of the index finger and its attached lumbrical to the thenar insertion.

FIG. 13. A, intrinsic arthritic contracture of the fingers. The appearance of the hand at the first operation. The iodine-colored hand is lying on sterile drapes. The proximal interphalangeal joint showed only a trace of active flexion.

FIG. 13. B, a photograph taken in the operating room of the shortened collateral extensor tendons of one finger. They were lengthened in z-manner and the ends sutured to each other by a black stitch.

The Bunnell operation was modified experimentally, two free tendon grafts being attached to the motor. One tendon graft was attached to the normal insertion of the thenar muscles, and the other to the distal part of the first metacarpal, the intent being that the function of the opponens and short abductor of the thumb be each replaced. On pull of the motor, inequality of tension was noted in the grafts. A fascial tube, attached to the motor, was also used rather than a free tendon transplant. Finally, a fascial loop was passed about the first metacarpal and attached to the fifth metacarpal, an operative procedure which can be used to place the totally paralyzed thumb in a grasping position. In the paralytic hand, whose thenar muscles and finger flexors are paralyzed, but whose hypothenar muscles and little finger flexors are good, the little

FIG. 13. C, the opening and closing of the hand about a month postoperatively. (The operations were done between January 31st and February 26, 1936.) The dressing covers a silk stitch abscess of the ring finger. This improvement was not maintained because the patient did not co-operate in postoperative care.

finger may be made into a thumb by a rotation osteotomy of the base of the fifth metacarpal bone. It may be necessary to lengthen the web between the fourth and fifth fingers. The patient would then have two right hands or two left hands, depending on which hand is operated.

Lauenstein,[16] in 1880, osteotomized the bases of the second and fifth metacarpals in complete loss of the thumb.

Leather Strap to Hold the Thumb Opposed or Abducted. An inexpensive and simple leather strap was made to hold the thumb either in opposition or in abduction. The strap has a loop at one end which is placed about the base of the thumb. The thumb is opposed by pulling on the loop. The strap is placed about the hand from palmar to dorsal and then palmar again, where it is buckled to itself under appropriate tension. This placing of the strap is reversed for abduction of the thumb. Movements of the fingers are not interfered with.

This strap differs from the Goldthwaite wristlet,[17] the purpose of which is restoration of the relaxed carpal arch by compression of the wrist for more advantageous thenar and flexor muscle power.

FIG. 14. A spastic hand is seen in the upper left photograph before injection of the ulnar nerve at the level of the wrist by Dr. Milgram. The index and little fingers are in the intrinsic position, the middle and ring fingers in extrinsic flexion. Muscle action upon the fingers is therefore dissociated. The thumb is drawn into the palm and lies between the index and middle fingers. The wrist is palmarly flexed, a position less favorable to the development of intrinsic finger position or contracture. The other photographs were taken after injection of novocain about the ulnar nerve. The fingers become clawed and the thumb is out of the palm.

DISABILITIES OF THE ADDUCTOR MECHANISM OF THE THUMB—ADDUCTION AND PSEUDO-ADDUCTION DISABILITY OF THE THUMB —THE SEQUELAE OF ROTATION OF THE THUMB, POLLEX VALGUS AND ULNAR SESAMOIDITIS

Adduction of the thumb is an ulnar movement of the thumb in the plane of the hand by action of the first dorsal interosseous muscle and the oblique and transverse adductor pollicis muscles. The thumb is abducted by the abductor longus pollicis and the extensor brevis pollicis in the same plane. The extrinsic muscles balance the intrinsic adductor muscles in this uniplanar lateral movement.

The adductor muscles also balance the thenar muscles. The latter inserting on the radial tubercle of the base of the first

phalanx of the thumb, tend to rotate the thumb volarly. This rotation movement is counterbalanced by the adductor muscles abducted or opposed completely. This is easily tested by comparing spread of thumb and index finger on each side and

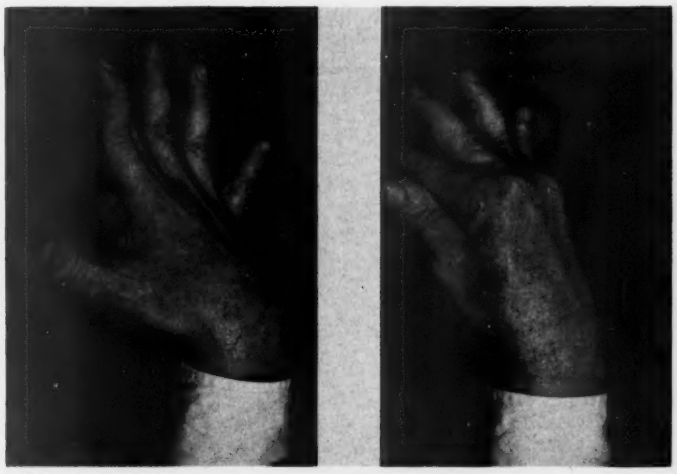


FIG. 15. Extensor variant positions of the fingers. A, *the spastic band:* The left photograph shows the attempt at common (extrinsic) extension, the movement being carried out in palmar flexion of the wrist. The fingers, particularly the index fingers, show flexion of the distal joint and hyperextension of the proximal joint. Note the prominence of the two extrinsic extensor tendons over the dorsum of the proximal phalanx of the index finger. The right photograph shows the hand when the patient tries to put the fingers into the intrinsic position. There is lesser flexion of the distal joints, the thumb is drawn somewhat into the palm, and there is lesser palmar flexion of the wrist. The extensor variant deformity is present in both positions, extrinsic and intrinsic, of the fingers.

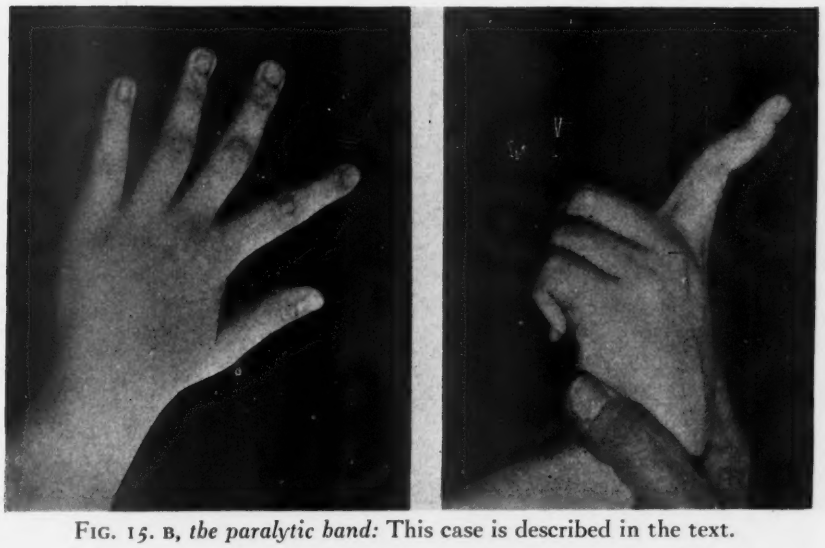


FIG. 15. B, *the paralytic band:* This case is described in the text.

which insert on the ulnar tubercle of the same phalanx.

Adduction contracture of the thumb is not uncommon. The adductor muscles are shortened so that the thumb cannot be by opposition of each thumb. The palmar fibers of the adductor muscles may be most shortened. The fascia contracts, especially the sharp edged fascia beneath the web. The web itself becomes smaller

but it is not necessary to lengthen it after adductor tenotomy and fasciotomy.

The adduction contracture is often only a part of a complicated hand disability. The fingers may be clawed, in neutral position or in intrinsic position.

In the spastic hand, it is more likely that the adduction contracture will be a part of a more or less diffuse spasticity in the region of innervation of the motor branch of the ulnar nerve. Or, the spasticity may be uneven, greater in the thumb or in the fingers. This contracture is sometimes seen in radial or posterior interosseous nerve palsy by imbalance between the adductors of the thumb supplied by the ulnar nerve and the paralyzed abductor longus pollicis supplied by the radial nerve. Sometimes in ulnar nerve palsy, the web of the thumb and the fascia of the paralyzed adductor muscles become tight, so that a mild adduction contracture exists. The arthritic hand occasionally shows adduction contracture, especially in arthritis of the carpometacarpal joint.* The traumatized hand may show this contracture as a result of direct local trauma or of improper splinting. Clawing of the fingers by ischemic contracture is sometimes associated with adduction contracture of the thumb. An untreated chip fracture of the radial tubercle of the basal phalanx of the thumb may give similar contracture. It is possible to have an adduction contracture as an end result of infection of the hand. The association of adduction position or contracture with the extrinsic deformity of the thumb has been discussed.

Fig. 15. c, *the arthritic hand:* All the joints of this extremity were involved.

Fig. 15. d, hyperextension of the proximal joint of the index finger after laceration of its flexor tendons. Flexion of the metacarpophalangeal joint is by interosseous action. The distal joint is extended and there is no extensor variant deformity.

It is only the severer forms of this contracture which held operative relief. The technic of this operation has been described and its use in the relief of spastic adduction contracture.[18,19] This operation was used in five cases for the relief of adduction contracture by other cause. The adduction contracture of the thumb in claw hand after trauma or infection is corrected

* It is pertinent to point out that adduction contracture of the thumb may follow arthritis of its carpometacarpal joint, the intrinsic deformity arthritis of its metacarpophalangeal joint, and the extrinsic deformity arthritis of its interphalangeal joint.

by a release of all the tight structures, a pedicle graft covering the area of skin defect (Mayer).

Fig. 15. E, extensor variant deformity of the index and middle fingers. The index finger is ankylosed at its interphalangeal joints as a result of an old infection. The flexor tendons of the middle finger had been cut many years before examination.

One man had an infection of the forearm after a bullet wound with resulting ankylosis of the wrist and elbow. The adduction contracture followed improper splinting. The second man had a paralysis of the posterior interosseous nerve following a bullet wound, and the contracture was in part due to imbalance of power between the adductors and the paretic long abductor of the thumb, and in part to a second bullet wound which entered the dorsum of the hand near the head of the first metacarpal and made its exit on the thenar eminence. The third man, wounded in the region of the left antecubital fossa by an explosive bullet, had a thick scar in this fossa, which bound down its structures. There was no definite nerve palsy, and the clawing of his hand, and flexion deformity of his wrist were considered ischemic in character. The radial nerve had been explored and it is possible that the adduction contracture of the thumb was due in part to imbalance between the adductors and extrinsic abductors of the thumb. The fourth case is that of the man whose extrinsic thumb deformity was corrected at the same time adductor section was done. In the fifth man, adduction contracture of the thumb followed improper splinting of the hand, after operation for a complete avulsion of the flexor tendons of the index finger.

In all five cases, adductor section was one of a number of operations done. In two, wrist fusion and adductor section were done simultaneously.

(Wrist position influences abduction and adduction of the thumb. In full dorsiflexion, abduction of the thumb is strained while the thumb moves more freely when the wrist hangs in palmar flexion. Strongest action in abduction and adduction occurs in the neutral position of the wrist, that is, in some dorsiflexion, and it is in that position that the wrist is usually stiffened. The wrist should not be arthrodesed in full dorsiflexion, for this position will not give maximal thumb and finger power.)

It is not to be expected that release of adduction contracture will give a free range of abduction and adduction. The power of adduction is not lost after operation. The end result is dependent not only on proper

operative release but also on adequate post-operative physiotherapy. The result of this section was good in the first man. In the second and third, follow-up was inadequate to determine the end result. The follow-up was long in the fourth case with some improvement in abduction and opposition. The last man showed good improvement in abduction two weeks after operation but has not been seen since.

It is necessary to amend the statement that the adductor muscles reattach themselves to their usual point of insertion. This does not seem to be so.

PSEUDO-ADDUCTION CONTRACTURE OF THE THUMB

In opposition contracture of the thumb in spastic paralysis, in median nerve predominance in a hand whose radial or ulnar nerves are paralyzed, in arthritis or otherwise, the web of the thumb and the adductor muscles become shortened *secondarily*. The first metacarpal bone is immovably opposed between the index and middle fingers and the carpometacarpal joint of the thumb is contracted volarly. The thumb itself is usually in the palm, but need not be, for it may show fixed extrinsic deformity or unusual rotation.

This is not a true or primary adduction contracture, since it is not a contracture in the plane of the hand. It is a pseudo-adduction contracture of the thumb by thenar muscle (and hence, median nerve) predominance in a plane anterior or volar to the hand.

Adductor section alone will not correct this deformity. Section or stripping of all shortened structures is necessary and this means thenar muscle stripping plus volar capsulotomy of the carpometacarpal joint of the thumb. The metacarpophalangeal joint of the thumb may also need capsulotomy.

SEQUELAE OF ADDUCTION CONTRACTURE AND ADDUCTOR SECTION

Rotation of the Thumb. Volar rotation of the thumb by pull of the thenar muscles has been observed after adductor section since the counterbalancing force of the adductors is lost. The nail of the thumb faces more volarly. This rotation was slight in the one case in which it was seen and did not disturb function of the thumb.

Such volar rotation of the thumb may develop spontaneously in pseudo-adduction contracture of the thumb by pull of the relatively stronger thenar muscles. Two such instances were seen. In one man, it followed the development of this contracture after ulnar and posterior interosseous nerve palsy. An extreme degree of such rotation was observed in a spastic hand, the deformity of which is pictured before and after its correction.

Dorsal rotation of the thumb has not been noted after thenar stripping. It is possible and should be looked for, not only after this operation but also in the hand showing imbalance of muscle power between the median and ulnar nerves in favor of the latter.

POLLEX VALGUS AND ADDUCTION CONTRACTURE OF THE THUMB

Pollex valgus deformity is a rare sequel by adductor pull after thenar muscle stripping or after injury to the region of insertion of the thenar muscles. The thumb becomes deviated ulnarly with reference to its metacarpal. Valgus deformity has not exceeded 10°. The extensor longus pollicis may maintain or increase this valgus secondarily.

In long standing valgus, a mild secondary adduction contracture of the thumb develops. A mild flexion contracture of the metacarpophalangeal joint may also be present coincidentally by shortening of the thenar muscles or by contracture of the volar capsule of the metacarpophalangeal joint of the thumb.

Pollex valgus was seen once in a spastic hand after stripping of the thenar muscles. Two other instances have been observed. A boy of fourteen had a supernumerary thumb removed as a child. The incision was placed as the incision for thenar

stripping. A valgus deformity of the left thumb was now present with radial prominence of the first metacarpal head. The extensor longus pollicis tendon was angulated making an obtuse angle ulnarly. Action of this tendon increased valgus of the thumb. The thumb could not be brought to neutral position. Slight limitation of flexion was present at its metacarpophalangeal joint as well as a mild adduction contracture. The hand was otherwise normal. He was able to oppose, although the opponens muscle was a little atrophic, and to extend and abduct the first metacarpal bone.

A man of thirty-seven had injured each thumb as a child. As a school boy, he used to run precipitously down the school steps, and he struck the radial side of each thumb against a wall on several occasions. This side of the thumb was large and sometimes swollen. He recently complained of pain over the ulnar sesamoid of the right thumb, so that it became difficult to lift bundles.

Each thumb showed a radial prominence of the first metacarpal head and valgus of the thumb, more marked on the right side. A mild adduction contracture of the right thumb was present. There was very marked tenderness over the apparently enlarged ulnar sesamoid of the right thumb. He could not extend the metacarpophalangeal joint of the thumb fully. The roentgenogram of the right hand showed an old ununited chip fracture in the region of the radial aspect of the base of the proximal phalanx, at the site of the thenar muscle insertion. Soft tissue swelling was present at this site. The thumb showed a pollex valgus deformity of 10° and a flexion position of 170° at the metacarpophalangeal joint.

The chip fracture caused relative weakness of the thenar muscles so that adductor predominence gave first a pollex valgus deformity, then a mild adduction contracture, and lastly, ulnar sesamoiditis by occupational strain. It should be remembered that the ulnar sesamoid of the thumb is placed in the tendon of insertion of the adductor muscles.

Ulnar sesamoiditis is a late sequel of adduction contracture. Enlargement and tenderness of the ulnar sesamoid was also noted in two other cases, that of a man with posterior interosseous nerve palsy, and in a woman with arthritis of the carpometacarpal joint of the thumb.

FIG. 16. A, *flexor variant deformity:* The arthritic hand, showing both flexor and extensor variant deformities of the fingers. B, flexor variant deformity in each fifth finger, which shows congenital flexion contracture of the proximal interphalangeal joint.

PARALYSIS OF THE ADDUCTOR MUSCLES

Adductor paralysis is seen in infantile paralysis and in paralysis of the ulnar nerve or of its motor branch. The power of adduction of the thumb is not necessarily lost, given a strong extensor longus

pollicis, whose tendon shifts medially on each substitutionary adduction movement. This substitutionary power is necessarily weaker than normal adduction.

No operation had yet been devised to replace the paralyzed adductor muscles nor is such an operation usually needed.*[20]

OTHER DISABILITIES OF THE ADDUCTOR MECHANISM OF THE THUMB

Traumatic Atrophy of the Adductors of the Thumb with Interosseous Muscle Contracture in Abduction and Adduction by Diagonal Palmar Force. This is a unique case, worthy of detailed record:

Case v. G. J., a Greek wrestler of twenty-four, was hit on the palm of the left hand by the night stick of a policeman, more than six years before examination. He turned his left arm out and back to protect his back. The palm received the force of the blow, direction of force being diagonal, between thumb and fingers. The hand was acutely painful and soon became swollen and ecchymotic. He could not move the thumb for almost a week. After three weeks, he could again use his thumb, even in adduction. He wrestled professionally for four months and during this period, he also worked as a counterman in a restaurant.

In the fifth month after his injury, his hand became so weak that he began dropping things. He was unable to pick up a small light thing. He was usually unable to lift a pound weight. The weakness seemed one not only of the hand but also of the wrist. There was occasional dull ache in the hand on effort. He now noted an unnatural hollow in the interspace between the thumb and the index finger.

A deep hollow was seen in the first dorsal interspace of the left hand. The first dorsal interosseous muscle and the adductors transversus and obliquus were absent. On palpation, the fragment of the adductor transversus was felt near the head of the second metacarpal bone, and the thin tender remainder of the adductor obliquus near its base. The metacarpal origin of the first dorsal interosseous muscle was not tender. He could adduct the thumb with a little power by means of the extensor longus pollicis, although the tendon shifted medially with a slight sound as it adducted the thumb. The adducted thumb was easily forced into abduction.

Flexion of the metacarpophalangeal joint of the thumb was limited to 115°. The flexor longus pollicis was weak. Extension of the thumb was good. The slightly atrophied thenar muscles were weak, and although opposition was possible, he could not bring the thumb to the little finger. Active abduction of the thumb was weaker than normal.

Flexion and extension of the fingers were good, except for weakness of little finger flexion. There was hypothenar atrophy. The sinking-in of the dorsal intermetacarpal spaces indicated obvious dorsal interosseous muscle atrophy. The more unusual thing was the visible evidence of volar interosseous muscle atrophy in the palm. Intrinsic adduction of the fingers was weaker than normal. There was maintained intrinsic adduction position of the index finger, indicating fair power in the first volar interosseous muscle. He could not abduct the index finger intrinsically. The fifth finger was held in intrinsic abduction contracture by a strong abductor digiti quinti brevis muscle.

The grip of the hand was weak. He could not use the hand for detailed or skillful movements.

MEASUREMENTS OF THE HAND

Circumference at	Left Hand, Inches	Right Hand, Inches
1. Metacarpal heads	7⅞	7⅞
2. Palm	7⅝	8½
3. Thenar region, thumb in abduction	9	10
4. Wrist	6⅞	6⅞

Analysis of this hand indicated a general weakness of the intrinsic muscles, including the special muscle groupings of the thenar and hypothenar eminences. Some of the extrinsic muscles were weak, particularly the flexors of the thumb and little finger.

The complete absence of the adductor mechanism of the thumb was in part compensated for by an adductor action of the extensor

* Bunnell, since this was written, used a tendon loop operation to restore thumb adduction, the motor being the extensor communis tendon of the index finger. The tendon was prolonged by a tendon graft passed subcutaneously to the palm of the hand about the ulnar border of the hand and attached to the ulnar tubercle of the thumb's proximal phalanx.

longus pollicus. The first dorsal interosseous muscle lacked both its functions and an intrinsic adduction contracture of the index finger followed by imbalance between it and the first volar interosseous muscle. A more unusual finding is the intrinsic abduction contracture of the fifth finger by greater power of the abductor of the little finger over the weak third volar interosseous muscle.

Operation was recommended but the patient refused. The operative plan included three distinct operative procedures: a fascial plastic to reattach the adductor remains to their normal insertion, an extensor plasty of the index finger to restore its first dorsal interosseous muscle action, and lastly, proximal stripping of the tendon of insertion of the abductor digiti quinti brevis muscle.

ADDUCTOR AND FIRST DORSAL INTEROSSEOUS MUSCLE STRAIN

Interosseous muscle strain is described elsewhere but the following case is worthy of note because the force creating disability was like that of the preceding instance:

Case VI. A man struck the palm of his hand against the floor in a fall, the direction of force being diagonal between thumb and index finger. The first dorsal interspace was swollen and there was tenderness over the adductor muscle group. Tenderness was most marked over the point of insertion of the first dorsal interosseous muscle. Pain was increased when the tendon of insertion was stretched, when the index finger was forced into intrinsic adduction. Abduction of the thumb was painful by stretching of the adductors.

Occupational injury may also strain the adductor mechanism of the thumb, making painful not only adduction of the thumb, but intrinsic radial abduction of the index finger.

A case report (Case VII) by Stewart[21] indicates that a rupture of the adductor muscles is possible by a compressing force:

Case VII. An ice worker caught his left hand between two blocks of ice. The mass of muscle which protruded through a laceration in the web between thumb and index finger was the adductor pollicis, completely detached from its origin but still retaining its tendinous insertion. The herniated muscle was resected close to the insertion. A satisfactory restoration of thumb function was said to have been attained.

DISABILITIES OF THE HYPOTHENAR MUSCLES

Hypothenar muscle disability is not common. It is reflected in little finger dysfunction. The hypothenar mass has its proper flexor and abductor muscles, and an opponens muscle. Because the little finger is bound to the ring finger in the plane of the hand, hypothenar muscle disability is not very important, nor comparable with thenar disability.

In the athetoid hand, the hypothenar muscles are in constant spasm, drawing the little finger forward in a sort of opposition. The cup of the palm deepens, accenting the mass of the hypothenar muscles. The little finger, now held in intrinsic flexion and abduction, soon claws and there is tireless alternation of the finger between these two positions.

However, contracture in the intrinsic position of flexion-abduction does take place in the spastic hand. *Spastic or dystonic crossing of the little finger* over or under the ring finger is sometimes seen. The ring finger for instance, is held in intrinsic ulnar adduction over the extrinsically flexed little finger, or the reverse may be true.

The disability of the spastic hypothenar muscles is never isolated but is only a part of the greater picture of spasticity.

The hypothenar muscles are not infrequently paralyzed in infantile paralysis and ulnar nerve paralysis. In both, a clawing of the little finger takes place, given common extensor power, not only because of paralysis of the flexor brevis and abductor brevis of the little finger but also because of the usually associated lumbrical paralysis. An abduction position of the little finger (by action of the extensors of the little finger) is considered to be an early and frequent sign of ulnar nerve palsy.[22]

Traumatic contracture in the intrinsic flexion abduction position was seen twice.

The bony borders of the carpal canal are normally balanced by an equality of thenar and hypothenar muscle pull. Kinetic imbalance between thenar and hypothenar muscles in favor of the former may cause rotation of the scaphoid bone volarly. Such imbalance may be seen in scalenism, in that the muscles of the hand supplied by the median nerve have a relative or actual predominance over the muscles supplied by the ulnar nerve.

The obliquely directed fibers of the thenar muscles pull on the tuberosity of the scaphoid through the agency of the transverse carpal ligament.

This theory is not meant to be restricted to scalenism alone but to any lesion causing loss of hypothenar power. It needs the confirmation of more experience.

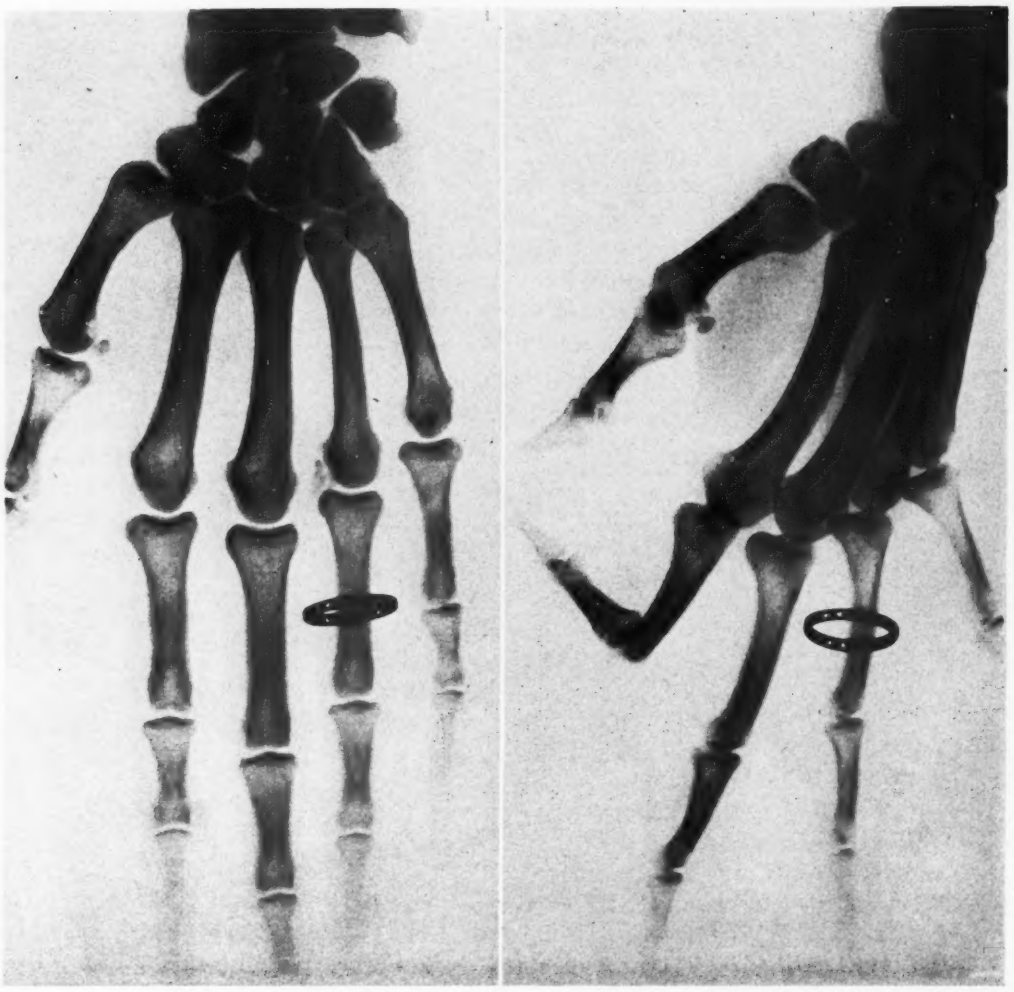


Fig. 17. Calcification within an intermetacarpal bursa.

EXTENSION DISABILITIES OF THE FINGERS—INTRINSIC EXTENSION DEFORMITY OF THE FINGERS

The intrinsic muscle mechanism of the finger balances common flexion and common extension. When this mechanism is dominant, the finger is flexed at the metacarpophalangeal joint and extended at the proximal and distal interphalangeal joints. The index finger is more often on a higher level than the other fingers. The sharp edge of the extensor aponeurosis of the dorsum of the first phalanx may be palpated.

The hand cannot grasp adequately because of this deformity, which is either mutable or fixed.

It is seen in three of the four groupings of hand disabilities, the spastic, arthritic, and in the traumatized hand, but not in the paralytic hand since the intrinsic muscles are usually paralyzed.

This deformity in the spastic hand means hyperinnervation in the distribution of the motor branch of the ulnar nerve, so that adduction position or contracture of the thumb is not infrequently a part of deformity. The intrinsic position is either constant, irregularly alternating, or dissociated, as in the athetoid hand. The "pill roller" hand adequately expresses the conception of fixed deformity.[23]

The arthritic hand not infrequently shows fixed intrinsic deformity, with or without adduction contracture of the thumb, or intrinsic deformity of the thumb; or, one or more fingers may only show intrinsic dominance.

Laceration of finger flexor tendons does not immediately give hyperextension deformity. It may or may not develop some time after tear. If the two flexor tendons are functionless, the balance of power passes to the extensor side, and the proximal and distal interphalangeal joints are held in extension. This extension is more intrinsic than extrinsic, for the metacarpophalangeal joint flexes when the flexion effort is made by interosseous muscle action. The extensor rebounds are strong and there are no flexor rebounds. The finger is out of the palm when the fist is made, but can be passively flexed if there is no contracture. Yet, synergistic flexion of such a finger was once seen. If the flexor profundus is intact, the extensor variant deformity may follow. It is, however, more usual that, when the sublimis tendon is torn, the profundus tendon is also torn or bound by adhesions.

The surgery of the intrinsic extensor mechanism is delicate and the end result dubious, but Bunnell's work may point the way to better result. Such surgery may be by-passed.

Test injection of the ulnar nerve by novocain in the lower forearm or of its motor branch between the hamate and pisiform allows preoperative estimate of reversal of finger position in the diffusely and evenly hyperinnervated spastic hand or fixed arthritic hand. If reversal to claw position is complete, resection of the motor branch is not indicated; if, however, there is incomplete reversal to a more neutral position of the fingers, given capsular contracture of the phalangeal joints, then it is indicated. Alcoholization of this nerve may be indicated instead of resection, but it is an operation of compromise within the limited field of incomplete reversal of the finger whose phalangeal joints are only slightly contracted. Resection of the motor branch of the ulnar nerve, introduced by Steindler,[24] is probably best indicated in the fixed intrinsic deformity, either spastic or arthritic. A similar operation is used for the correction of fixed intrinsic deformity of the foot, the motor branch of the lateral plantar nerve being resected.[25]

FIG. 18. The fourth and fifth metacarpal heads are depressed in the right hand. This is not an unusual finding in the hypotonic hand, the ulnar half of which shows relaxation. In this case, interosseous muscle imbalance was due to obscure scalenism and relieved by scalenotomy, with better postoperative alignment of the knuckles.

In two cases, section and stripping of the collateral extensor tendons were done, once in a mutable spastic hand with intrinsic dominance and once in a fixed arthritic hand. In the spastic hand, it was

observed that intrinsic extension diminished progressively to the little finger. It was decided to resect the collateral phalangeal joint, and if it is not sectioned transversely, an extensor variant deformity follows. This did happen in the index

FIG. 19, A, the ring finger is radially abducted by weakness of the fourth dorsal interosseous muscle, a preoperative photograph taken January 9, 1939. B, after extensor tenoplasty, the ring finger can be ulnarly abducted. A postoperative photograph taken May 19, 1939.

extensor tendons only in the index and middle fingers, for it was believed that reduction in spasticity of these fingers would diminish spasticity of the ring and little fingers by a sort of sympathy in which reduction of spasticity at one point lessens adjacent spasticity. The tendons are approached by radial and ulnar oblique incisions over their course, the incisions beginning just proximal to the distal interphalangeal joint and ending at a point just proximal to the proximal joint. The common extensor tendon is an important factor in the maintenance of intrinsic extension deformity of the proximal interfinger and secondary transverse section of the common extensor tendon was necessary. It need not be feared that common extensor power will be fully lost, for the tendon can only slip proximally a short distance in its binding extensor aponeurosis. The operation gave flexion position of the index finger, especially sublimis flexion. Ultimately, there was only slight improvement in passive grasping, the fingers being usually held in flexion position. Active extension was slight.

Three factors contributed to the fixed intrinsic finger deformities of the arthritic hand: a tight common extensor tendon,

contracted collateral extensor tendons, and shortened collateral ligaments of the proximal interphalangeal joint. The deformity could be passively corrected only when each of these three structures was released, either by section and stripping, or z-lengthening. The immediate result was fairly satisfactory but the late result was not, since the patient received no postoperative physiotherapy and did not co-operate in treatment.

The stripping of the collateral extensor tendons seemed to give a little better result than the z-lengthening. Slight recovery of extensor power of the distal phalanges was observed after either procedure, and an extensor rebound was elicited in the finger in which the collateral tendons were stripped because they were sutured to the common extensor tendon.

Resection of the motor branch of the ulnar nerve is simpler and should be more efficacious. In either operation, it must be made certain that there is no active arthritic inflammation of the phalangeal joints.

DEFORMITY OF THE FINGER BY COMMON EXTENSOR DOMINANCE

A form of common extensor dominance is considered here in which there is extension of all three phalangeal joints. The common extensor tendon can extend the distal two phalanges when the finger is straight.

There may be extreme voluntary hyperextension of the fingers of the normal hand.[26] The spastic hand sometimes shows extension of the three phalangeal joints as a mutable deformity. The hand with diffuse common extensor dominance may show volar depression of the metacarpal heads and arborization of the fingers.

Postoperative extension contracture of the paralytic finger is seen after the suture of the intrinsic extensor apparatus to the common extensor tendon.

Case VIII. Sylvia U., a girl of seven and a half, with an infantile paralysis so extensive that she was never able to stand or to walk, showed the not uncommon paralysis of the small intrinsic muscles of the hand. The left

Fig. 20. Congenital hypertrophy of the first lumbrical muscle.

hand is the one which concerns us. The left wrist was in neutral position and the fingers of the left hand were clawed.

Traction extended the fingers but maintenance of the correction achieved was not possible.

Dr. J. E. Milgram suggested that extension of the second and third phalanges might be attained by common extensor action. A somewhat similar idea was used by von Hacker[27] to repair a traumatic defect of the common extensor tendon of the index finger. The proper extensor of the index finger was cut transversely at the level of the metacarpophalangeal joint, reflected distally and made to insert on the end phalanx. Its proximal stump was joined to the stump of the common extensor tendon at the level of the metacarpophalangeal joint.

Operation was done on one finger on February 3, 1937. The proximal interphalangeal joint was stretched to overcome flexion contracture. A mid-line incision, which began about one-half inch proximal to the metacarpophalangeal joint and extended to the distal interphalangeal joint, exposed the en-

tire extensor apparatus. (This incision is open to criticism since the tendon underlies the incision.) The extensor apparatus over the second phalanx was thin and atrophic. It was freed, sutured to itself, and then to the freed common extensor tendon by two black silk sutures. The extensor tendon was split and an ulnar strip reflected distally and sutured to the extensor mechanism of the second phalanx, in order to re-enforce it. The finger was splinted in extension at all its joints.

Extension contracture of all three joints of the finger followed this operation. This was considered worse than the original clawing, since the finger could not be placed for grasping. A strap was made to hold the finger bent and exercises in flexion begun.

A month after operation, the proximal interphalangeal joint was held in 10° of flexion, and the distal interphalangeal joint in full extension. By extending the finger at the metacarpophalangeal joint, she extended the interphalangeal joints. These showed no independent motion in extension indicating that the common extensor tendon now acted upon its new insertion point on the distal phalanx.

It was noted in September, 1938, that the extension contracture of the finger had been overcome. She was able to flex the finger to 90° at the proximal interphalangeal joint. The distal two phalanges could not be extended and the transplant was reckoned as a failure.

The wisdom of the normal double extensor apparatus is demonstrated in this case. Even if the operative plan had succeeded, it could not have duplicated the coordinated and yet independent actions of the double extensor apparatus.

Relaxation of the radial half or border of the paralytic hand is sometimes seen, whose common extensor strength is greater than its common flexor strength. Relaxation of the ulnar border of the hand is most often hypotonic.

PARALYSIS OF THE COMMON EXTENSOR MECHANISM

When the common extensor tendons are paralyzed—and this is noted in radial nerve palsy and infantile paralysis—the fingers cannot be extended at the metacarpophalangeal joints, but can be extended at the proximal and distal interphalangeal joints. In radial nerve palsy or after suture of a torn radial nerve, extension of the distal phalanx of the thumb may be by intrinsic action rather than by action of the extensor longus pollicis.

The treatment of common extensor paralysis by fusion of the wrist with or without flexor to extensor transplant is well known. It would seem unwise to transplant the dorsal interossei to give common extensor function, as Stoffel[28] advised.

The inability to extend one or more fingers by laceration or fixation of the extensor tendons does not concern us here.

OTHER DISABILITIES OF THE EXTENSOR APPARATUS

Congenital anomalies of the extensor tendons sometimes cause disability. This subject is well covered by Pfeiffer's paper.[29]

There may but need not be congenital anomaly of the extensor tendons in congenital shortening of a metacarpal. It is usually the fourth metacarpal which is short.

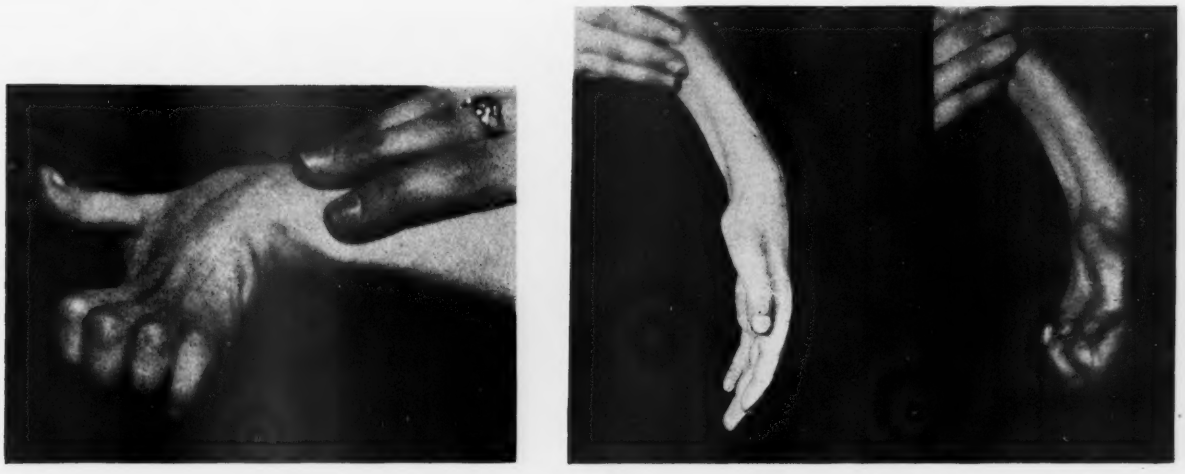
Congenital hyperextension of the distal phalanx of each ring finger, causes no functional disability.

Luxation of the common extensor tendon at the level of the metacarpophalangeal joint is uncommon.

Two recent papers discuss this subject adequately. Fitzgerald's[30] case, a woman of twenty-two, showed ulnar luxation of the extensor tendons of the index, middle, and ring fingers of one hand due to absence of the extensor aponeurosis over the proximal part of the first phalanx. Strauss'[31] review of the literature and the presentation of his own case show that most cases are traumatic in origin, and that there must be rupture or division of the dorsal capsule of the joint before lateral displacement of the tendon is possible. The radial half of the extensor tendon may also be torn.

It was noted that, after the division of the conjoined extensor tendons in one

case in which the Shaw operation was done, the extensor tendons subluxated ulnarly.



A B

Fig. 21. A, a preoperative photograph (January 13, 1936) of a paralytic claw hand. The extensor tendons are contracting actively. B, a photograph (June 6, 1941) taken about five and one-half years after the Shaw operation. The hand is shown at rest and as the fingers flex.

The congenital form is most unusual. In Levy's case, as described by Mason,[32] the familial occurrence of this luxation is commented upon.

A mother and daughter were seen in whom this luxation seemed congenital and familial.

Case IX. The extensor tendon of the right middle finger (of Mrs. D. O., forty years old) was displaced ulnarly with audible snap on voluntary, forced, full flexion of the metacarpophalangeal joint, and slipped back into place on extension. Both luxation and replacement of the tendon were easily done and painless, but she noted that repetition of luxation was painful.

Thirty three years before she fell while skating and struck the knuckles of her right hand against the curb. She heard a cracking sound in the hand as she struck it. She had never been treated for this luxation.

Her daughter, eighteen years old, had exactly the same thing. The extensor tendon of the right middle finger dislocated ulnarly when it was flexed passively by the thumb. The beginning of luxation was not known and she remembered no trauma.

Radial subluxation of the extensor tendon of the right index finger was seen in a woman's hypotonic hand. After recent use of a paring knife, the tendon slipped radially as the index finger was placed in ulnar adduction. The inconstant slipping was not painful.

Luxation of the extensor tendon of the index finger may take place more proximally over the prominent dorsal tubercle of the dorso-ulnar base of the second metacarpal.[33]

Tumors of the intrinsic extensor apparatus are uncommon. Three patients were operated upon. In two, a discrete giant cell tumor was attached to the collateral extensor tendon. In the third, a lobulated tumor, grossly a xanthoma, was adherent at several areas to the collateral extensor tendons, and to the flexor tendon sheath of the middle phalanx of a finger. No tumor caused kinetic disability of the finger.

VARIANT POSITIONS OF THE FINGER

The variant positions of the finger are positions of the finger intermediate to the determinate deformities of the finger—the claw finger and the finger in intrinsic position—by dissociation of extensor power, flexor power or both. The term, variant, is used advisedly, for these finger positions are variants of the determinate deformities.

Extensor Variant. The finger is hyperextended at the proximal joint and flexed at the distal joint. The metacarpophalangeal joint is in flexion. Attempt to extend the distal phalanx usually causes increase in extension of the proximal joint. The proximal joint may be flexed actively, especially in the milder degrees of deformity and before contracture develops. The finger may sometimes flex with a snap as the common extensor tendon rides radially.

There are two mechanisms which may create this deformity: a weakness of the intrinsic extensor mechanism, or a weakness of flexor sublimis action. Extensor rebound is weak or absent. Were the intrinsic extensors the equal of the flexor profundus, the intrinsic deformity would develop. In this sense, this finger deformity is a derivative or variant of the finger with intrinsic deformity.

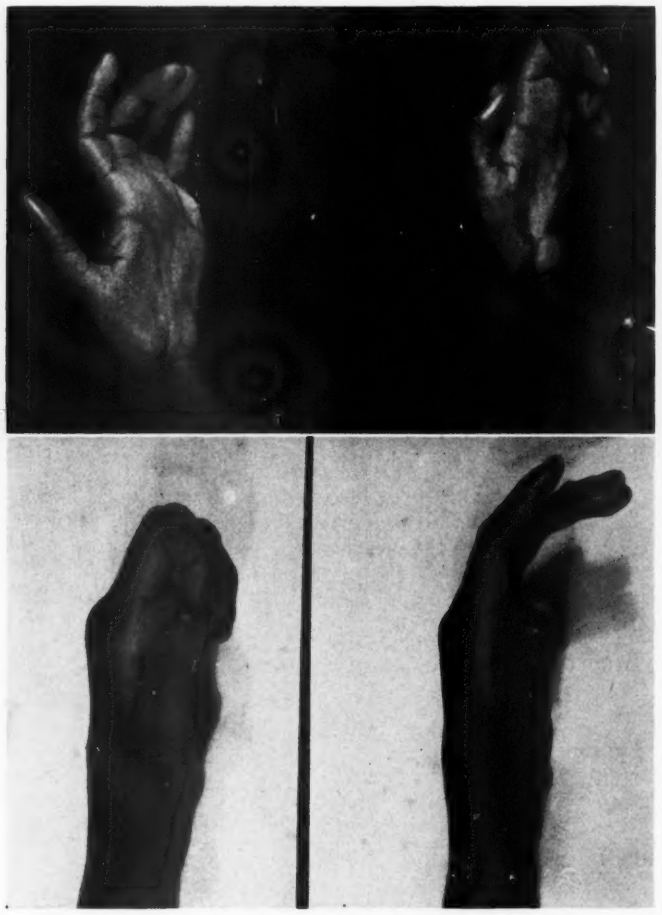


FIG. 22. A, a preoperative photograph (June 14, 1935) of the paralytic claw hand. B, a photograph (July 25, 1941) six years after the Shaw operation. The hand is shown at rest and with the fingers bending actively.

The wrist, therefore, is usually in dorsiflexion rather than in palmar flexion.

The flexed distal phalanx tenses the extensor cords. This phenomenon is possible only when all three phalangeal joints are extended, or in the intrinsic position of the finger. The metacarpophalangeal joint may be hyperextended 10° or more in the former instance, but it is more usual that this joint is flexed. Forced flexion of the distal joint, the other phalangeal joints maintaining their position, tenses and makes prominent the extensor cords. This maintains or increases extensions of the proximal joint, while a bow string

action of the flexor profundus tendons does the same thing. The ineffectual attempt to extend the distal phalanx can only increase extension of the proximal joint. The anatomic mechanism which causes the extensor variant deformity is the more dorsal placement of the extensor apparatus, particularly that over the first phalanx. This has been confirmed by palpation in a few cases and by operation in one case.

The deformity is often seen after trauma. Kaplan[34] described the type following an injury to the volar surface of the distal two phalanges and pointed out that a tear of the lateral ligaments of the proximal interphalangeal joint took place with gradual retraction of the lateral bands of the extensor tendon dorsally. I have seen only one case of this type.

Case x. A boy of nine was seen at the New York Dispensary on May 5, 1941. The day before, he had been struck by a baseball on the volar aspect of the left middle finger. The ball rode the length of the finger to its tip and bent it back.

He had a mild extensor variant deformity of the finger. Extension of the distal phalanx to 175° was possible. Flexion of the finger was free but weaker than normal. The palmar aspect of the proximal phalanx was swollen and tender.

The finger showed flexor weakness, particularly flexor sublimis weakness, with undoubted strain of the anterior part of the proximal interphalangeal joint. Tearing of its lateral ligaments may have taken place. The mechanism of injury seemed to be due to extensor dominance; yet, the flexor profundus could flex the distal phalanx.

The more usual mechanism is one in which there is weakness (by tearing or stretching) of the intrinsic extensor mechanism of the distal phalanx, usually by a sudden flexion injury of the extended distal phalanx. Kaplan says that in those cases in which the flexion deformity of the distal phalanx is not due to avulsion of the extensor tendon, it is due to tear of the collateral extensor tendons and the binding triangular membrane over the mid dorsum of the middle phalanx. This observation is important but not categoric. A similar observation was made by Kausch[35] who repaired a traumatic tear of the intrinsic

Fig. 23. The photographs illustrate the arthritic hands of a young woman, the deformity of which was due to myositic shortening of the interossei muscles. The acute flexion deformity of the metacarpophalangeal joints did not allow hand opening nor adequate grip. The fingers showed both flexor and extensor variant deformities. The left hand was operated on August 8, 1942, the interosseous muscles of each finger being isolated, sectioned at their insertion and stripped proximally. Five incisions are needed as in the Shaw operation. She is making adequate progress. Resection of the motor branch of the ulnar nerve was not done because of good adductor power of the thumb.

extensor apparatus secondarily. The collateral extensor tendons were undermined and sutured to each other. This repaired the rhomboid defect found at operation and restored intrinsic extension.

An extensor variant deformity may follow the mallet finger and may be more common than is believed. It is the fault of kinesiologic imbalance and faulty treatment may accentuate this imbalance.

The arthritic hand and sometimes the spastic hand show the extensor variant deformity. I cannot state categorically that the extensor variant deformity is always seen in arthritis of the distal interphalangeal joint and the flexor variant in arthritis of the proximal joint. It was seen twice in the spastic hand, once after stripping of the forearm muscles from the internal epicondyle of the elbow, and once after section and stripping of the collateral extensor tendons of the index finger.

It is only in the spastic hand that this deformity is mutable, whereas tendency to fixation is greatest in the arthritic hand.

Fig. 24. An unusual deformity of the hand in a young woman, the principal features of which are the extrinsic position of both the thumb and little finger, opposition contracture of the first and fifth metacarpal bones, and loss of flexor function in the third, fourth and fifth fingers. An operative scar is seen in the palm of the hand, the operation being done for the control of secondary hemorrhage in the palm following its laceration by glass. The loss of flexor tendons function may be due either to the operation or to postoperative infection. The unusual position of the thumb and little finger is not caused by improper postoperative splinting, for the hand was not splinted. Scar tissue in the palm holds the thenar and hypothenar eminences in opposition in a hand which showed easy voluntary assumption of the extrinsic position of thumb and finger. This statement is verified by the examination of the normal left hand. Both the thenar and hypothenar eminences showed easy rebound into the position of deformity after passive correction. This is the first instance of *thenar* and *hypothenar rebound* encountered. The patient refused treatment.

I have seen an extensor variant deformity in the paralytic hand only once. It is rare because of the not uncommon association of intrinsic muscle paralysis with finger flexor paralysis.

Case xi. *Paralytic Extensor Variant Deformity*. The proximal joint of the left index finger of a paralytic girl of ten was hyperextended, while the distal joint was flexed. The metacarpophalangeal joint was slightly flexed. The common and proper extensor tendons stood out as tight bands on the dorsum of the first phalanx. The ulnar collateral extensor tendon was also felt as a taut band.

The finger was also held in intrinsic radial abduction because the first dorsal interosseous muscle was stronger than the first volar interosseous muscle. There was a slight increase of lateral play of the proximal joint and the second phalanx was deviated ulnarly a little.

All the fingers closed when she made a fist. Yet, sublimis flexion of the proximal joint of the index finger was only possible as an individual movement, when its first phalanx was held. Extension of the fingers was strong, and the fingers branched in a fanning (extension-abduction) movement, as the metacarpal heads sank more volarly. The distal joint of the index finger could be actively extended but its intrinsic extensor rebound was weaker than its flexor profundus rebound.

The extensor variant deformity was due primarily to flexor sublimis weakness.

In this case, ulnar obliquity of the second phalanx is caused by oblique pull of the extrinsic extensors of the index finger, and not by unequal pull of the collateral

extensor tendons. In the cadaver, such ulnar deviation of the second phalanx may be produced by pull on the ulnar collateral tendon when the radial collateral extensor tendon is sectioned transversely and stripped and when the radial capsule of the proximal joint is cut.

The normal hand may show the extensor variant as a poorly sustained, voluntary motion.

Flexor Variant. The finger is held in flexion of its proximal joint, and hyperextension of its distal joint. The metacarpophalangeal joint is in extension or hyperextension. This deformity is less common than the extensor variant, because, when this position is assumed in the normal finger, passive release of the hyperextension position of the end phalanx snaps the finger into flexion by a fairly strong flexor rebound.

In the normal finger, it is not possible to extend the distal joint actively when its proximal joint is maintained in a given position of flexion.

Two mechanisms of deformity are possible: Isolated tear or injury of the flexor profundus tendon may create this deformity but the flexor variant deformity was absent in the one case seen. The usual cause is weakness of the common extensor mechanism, by open tear or by subcutaneous rupture of the common extensor tendon.

When the triangular membrane is torn in subcutaneous or button-hole rupture, the collateral extensor tendons slip volarly, so that their contraction increases the dominant sublimis flexion of the proximal joint and extends the distal joint. The pull of the collateral extensor tendons is below the transverse axis of the proximal joint so that flexion of this joint is produced rather than extension (Kaplan). This volar displacement of the collateral extensor tendons has been noted by several investigators (Montant and Baumann, Foerster).[36,37]

The flexor variant deformity is noted in the arthritic hand, which may show one finger with the extensor variant deformity and another with the flexor variant deformity. Extension of the end phalanges in the arthritic flexor variant is positional, the pressure of the fingers against bed, table, or other things, pushing the fingers into extension or hyperextension. Sometimes, after passive flexion of the finger, the end phalanx is snapped back into extension with an audible sound because its extensor apparatus, which luxated on passive flexion, snaps back into place.

The extension deformity of the distal phalanx in congenital flexion contracture of the proximal joint of the little finger may be due to the same reason.

The deformity was not seen in the spastic or paralytic hand.

The deformity is comparable in a way to the claw finger, for were the distal phalanx flexed, it would resemble such a finger.

INTEROSSEOUS MUSCLE DISABILITY—DISABILITY IN INTRINSIC FINGER ABDUCTION AND ADDUCTION

The interosseous muscles flex the metacarpophalangeal joints of the fingers and also help extend their distal two phalanges. The first dorsal interosseous muscle is an adductor of the thumb and an abductor of the index finger. The four dorsal interossei are abductors of the fingers. The middle finger, balanced by the second and third dorsal interossei, is the relative axis from which the fingers spread or to which they adduct.

There are needed only three volar interosseous muscles, so that the middle finger has none.

The index finger is balanced by a relative equality of power between the first dorsal and first volar interosseous muscles, the ring finger by the second volar and fourth dorsal interosseous muscles, and the little finger by the third volar interosseous muscle and the abductor digiti quinti brevis muscles. Actually, more muscle power is needed to abduct the fingers than to adduct them and the dorsal

interossei have more bulk than the volar interossei. Clinically, dorsal interosseous atrophy is more often seen than volar interosseous atrophy.

Common extensor abduction of the fingers is secondary to the obliquity of course of these tendons. It should not be confused with interosseous abduction, and the differentiation is easily made. The fingers should be abducted in the intrinsic position to test interosseous abduction and not in extension of the metacarpophalangeal joint. Intrinsic adduction of the fingers is easily differentiated from the adduction of the fingers when they are flexed.

The extensor disability of the finger resulting from disturbance of interosseous balance can not ordinarily be dissociated from similar lumbrical disability. The preservation of lateral movement of a finger or fingers bespeaks interosseous muscle integrity, and hence integrity of its extensor function. If such extensor power be weak in adequate lateral balance of the finger, it may be assumed that either there is dissociation of interosseous power, one part of which is preserved, or that there is absence of power in the lumbricals. This situation is more theoretical than practical, for usually both are synchronously and equally paralyzed. It is difficult then to speak of disability of the hand as of pure interosseous or lumbrical type.

Disability is generalized or localized. In either case, it is expressed by under activity or over activity of the interossei. The finger is deviated either ulnarly or radially in the intrinsic position, if its lateral balance is uneven. General underactivity (weakness or paresis) is most often seen in infantile paralysis and ulnar nerve paralysis. The lumbricals are ordinarily paralyzed at the same time, except for the medial two lumbricals which remain strong in ulnar nerve palsy. Certain neurologic conditions show associated atrophy of the small muscles of the hand, as in amyotrophic lateral sclerosis and progressive spinal atrophy.

The fingers claw, because the balancing mechanism of both lumbricals and interossei is lost, and there is no lateral deviation of the fingers because small muscle paralysis is ordinarily diffuse and even. There may, of course, be uneveness in paralytic interosseous muscle disability.

Weakness of the interossei may follow in the wake of trauma or arthritis. There is obvious atrophy and sinking in of the dorsal intermetacarpal spaces, especially in the arthritic hand. The fingers may be ulnarly deviated at the knobby metacarpophalangeal joints, but this is a postural deviation. In the irritative phase (myositic) of the illness, and in the stage of muscle shortening, the fingers are maintained in the intrinsic position, rather than in the claw position, by the action of the interossei muscles. The arthritic hand may show palmar luxation of the proximal phalanges by interosseous action.

The purest form of general over action of the interossei is seen in the spastic hand, in the region of innervation of the motor branch of the ulnar nerve. Spastic abduction position of the fingers has already been described. The "pill roller hand" is an intrinsic adduction contracture of the fingers and thumb, either arthritic or spastic in origin. There need, however, be no lateral finger deviation. Rarely, the intrinsic muscles become diffusely dominant in a traumatized hand.

Localized disability in intrinsic abduction or adduction of a finger is not common. Isolated weakness of one or more interosseous muscles, while always possible in the spastic, paralytic, or arthritic hand is probable in intermetacarpal bursitis with calcification, in obscure scalenism, and after trauma.

The former condition is uncommon, cases having been described by Maseritz[38] and Cooper.[39] The bursa is mechanically irritating, and since it lies near the insertion of the affected interossei, it may disturb lateral balance of the finger, although no note is made of it in the published cases nor in the one case seen by me. The obvious

kinetic disability is limitation of extension of the affected finger and lateral balance of the finger is not tested.

In the typical scalenus anticus syndrome, diagnosis is based on association of neurologic and vascular lesions. There must be many cases in which the disturbances are minimal, so that there is difficulty with precisional diagnosis—cases of obscure scalenism in which there are relatively minor weakness of the interosseous muscles of the fourth and fifth fingers.

Two such cases are here reported. The second case seen is presented first, for it threw light on the first case.

CASE XII. Mildred G., a colored girl of nineteen, complained of a weak and tired feeling in the fourth and fifth fingers of the right hand for a year. The hand was not painful and occasionally she had a "pins and needles" feeling in the fingers. She had noted that the knuckles of the affected fingers were placed on a lower level than those of the index and middle fingers when she clenched her hand. The dorso-ulnar half of the hand was flattened and the fourth dorsal interosseous space was sunken in distally. She could not abduct the ring finger well, indicating weakness of the fourth dorsal interosseous muscle. The second and third volar interossei and the abductor digiti quinti brevis were strong. The relatively greater strength of the second volar interosseous muscle was shown by the radial displacement of the fourth metacarpal head, so that it approximated the third metacarpal head, thereby increasing the distance between the fourth and fifth metacarpal heads. There was hypotonic relaxation of the carpometacarpal joints of the fourth and fifth fingers. No sensory changes were present in the ulnar nerve distribution.

The little finger presented a mild familial clawing deformity with valgus deviation of the second phalanx on the first.

It was suggested by the house surgeon, Dr. Caroll Silver, that the probable cause for this slight imbalance of the interossei was not a local thing but due to an occult or obscure scalenism. The neurological consultant believed the condition due to pressure on the roots of the eighth cervical and first dorsal by the cervical rib found bilaterally in roentgenograms of the neck. The hands showed foreshortening of the fourth and fifth metacarpals on each side. Blood pressure readings on each side were 94/60.

A myotomy of the right scalenus anticus muscle was done on May 23, 1940. The postoperative course was not eventful. There was immediate improvement, which has been maintained (January 17, 1941). There is no muscle atrophy, only slight dropping of the fourth and fifth metacarpal heads, and the grip of the hand is good. She has no complaints.

Microscopic examination of the muscle showed striated muscle fibers, some of which were fragmented and hyalinized.

This patient illustrates the point that sometimes mild and obscure intrinsic muscle imbalances may be due to scalenism.

The following case, antecedent in time to the above case, seems in retrospect also to be due to obscure scalenism, although the neck was not examined.

CASE XIII. Mary F., fourteen years old, noted some difficulty in the individual use of her right fourth finger in typing, the finger catching under the third finger. At the age of one, she had diphtheria, followed by a right hemiplegia which was said to have resolved completely.

She could not abduct the ring or fourth finger intrinsically. The fourth dorsal interosseous muscle was weak, the second volar interosseous muscle strong. The third volar interosseous muscle was not as strong as the second. In extrinsic extension, the ring finger did not abduct as much as the others, and was radially deviated. This was not due to common extensor action for such action was strong, though the line of pull of the common extensor tendon was more oblique than normal. When the finger was placed in the intrinsic position ulnarly, release of the finger snapped it back radially. This is a lateral interosseous rebound. There seemed to be slight atrophy of both the dorsal and volar interosseous muscles. The circumference of the right hand was 6¾ inches, that of the left hand 7 inches. The patient was left handed.

The neurologist noted nystagmoid jerks of the eyes in the lateral plane, hyperactivity of all deep reflexes, easily exhausted and poorly elicited abdominal reflexes. A right Hoffmann and Babinski sign were noted. A residual hemiparesis with perhaps some involvement of the ulnar nerve after diphtheria was suggested.

Another neurologist believed the hand disability was not of neurogenic origin.

The disabling weakness of the fourth dorsal interosseous muscle was corrected by an extensor plasty. I had thought this operation original but it has been used by Bunnell[40] and by a German surgeon, the reference for whose work I cannot now find. The extensor plasty seems to be the simplest substitute for an isolated paralysis of an interosseous muscle. This method is most suitable when either the proper or common extensor tendon of index or little finger can be used. This makes the substitution by tendon transfer of the paralyzed second volar or third dorsal interosseous muscles difficult, unless the adjacent common extensor tendon be split in two. This seems inadvisable for it is expected that the common extensor tendon serve two actions, not always synergistic —common extension and intrinsic abduction or adduction. Extensor translocation instead of transplantation may be tried in a finger with two extrinsic extensor tendons.

The tendon chosen is sectioned transversely at the level of the metacarpophalangeal joint or a little distal to it, and sutured to the extensor aponeurosis of the base of the proximal phalanx near the normal insertion of the paralyzed interosseous muscle. The finger is then splinted in the intrinsic position in lateral deviation corresponding to the normal interosseous muscle.

This operation was done on January 14, 1939. An incision between ring and little finger exposed the extensor tendons of the fourth and fifth fingers. The incision was longitudinally placed, began at the level of the proximal interphalangeal joint of the little finger, and extended proximally 1½ to 2 inches. The conjoined tendon was cut and the common extensor of the little finger freed. It was cut transversely about ¼ inch distal to the metacarpophalangeal joint and sutured to the extensor aponeurosis of the ring finger at or near the normal insertion of the fourth dorsal interosseous muscle, the ring finger being held in intrinsic ulnar deviation.

The postoperative course was uneventful. An immobilizing plaster bandage was removed two and one-half weeks after operation. She received physiotherapy, including sinusoidal stimulation and active exercises. The result is an excellent one and the patient was quite satisfied when she was seen last on March 23, 1940. The use of the operated finger was good and the ring finger no longer caught beneath the middle finger. The ring finger had fairly good strength both in intrinsic ulnar abduction and in common extension, the wrist tending to flex palmarly as she executed these movements.

This case is a complicated one. Whether the paralysis of the affected muscle is postdiphtheritic, cortical, or by obscure scalenism is difficult to say. At any rate, a simple procedure gave clinical satisfaction.

Isolated contracture of a finger by interosseous action is not common but is most likely as the intrinsic abduction contracture of the little finger after trauma.

Crossed Fingers. The spastic hand may sometimes show crossing of the fingers, usually the fourth over the indrawn fifth finger. This finger may be in the intrinsic position, its overlapping finger in the extrinsic position, or both fingers may be in varying degree of the extrinsic flexion position or contracture. An instance of the latter was seen postoperatively in the hand of a woman unsuccessfully operated upon for the relief of Dupuytren's contracture. Pack[41] reported an instance of flexion and crossed finger deformity present since birth in a patient with congenital neurofibromatosis of hand and forearm. The index finger was crossed over the middle finger. He stated that this was a common neurogenic deformity.

INTEROSSEOUS MUSCLE STRAIN

Following a trauma, either direct or indirect, a strain of an interosseous muscle, usually a dorsal interosseous muscle, may develop. Usually, it is the first dorsal interosseous muscle which is strained. I have seen instances of second dorsal interosseous and third volar interosseous muscle strain. The strain of the first dorsal interosseous muscle may be a part of a more diffuse occupational hand strain. The belly of the affected muscle may be tender and there is usually a small, sharply localized, very painful spot at the site of insertion of the muscle. Pain is

increased when the muscle is stretched and this pain may radiate up the hand to the forearm or along the extensor aponeurosis. Resistance to the normal movement of the muscle is also painful.

Physiotherapy is helpful but sometimes it is necessary to inject this painful area with novocain (2 cc. of a 1 per cent solution) and alcohol (0.1 cc. of a 70 per cent solution) several times.

DISABILITIES OF THE LUMBRICAL MUSCLES

It is always difficult to differentiate pure lumbrical disability from pure interosseous disability, because both have similar action in intrinsic extension and because disability of one is usually associated with disability of the other. The finger with pure lumbrical disability shows weakness of intrinsic extension but no lateral deviation. This is not enough to localize disability anatomically.

The lumbrical muscles cannot ordinarily be palpated, with the occasional exception of the first. This may be felt when, the finger being flexed fully at its metacarpophalangeal joint and extended at its interphalangeal joints, the index finger bends in maintained metacarpophalangeal joint flexion. This test is informative in rare instances. All other tests of intrinsic extensor function test both lumbrical and interosseous power, by placing the fingers actively in the intrinsic position, by flicking the fingers, by finger squeeze, and by testing extensor rebound. The intrinsic lateral movement of the finger tests interosseous power, either singly, in an *en masse* to and fro ulnar and radial swing of the fingers to test them all in intrinsic abduction or adduction of the fingers, or in flexion of the metacarpophalangeal and proximal interphalangeal joints to rule out common extensor abduction.

The action of the two sets of muscles is co-ordinated in intrinsic movement. *Disability of one must be reflected in disability of the other.*

In the repair of interosseous and lumbrical disability, it will be more necessary to regain extensory power than lateral power. Most operative procedures try to do that.

CASE XIV. *Hypertrophy of the First Lumbrical Muscle with First Dorsal Interosseous and Adductor Muscle Strain.* In July, 1935, I saw a young woman of twenty-two, with a swelling of the palm of her right hand in the line of the tendons of the index finger. Exploratory operation under local anesthesia showed that the mass of the first lumbrical muscle was unusually large. The muscle was not resected.

In December, 1934, while wheeling a cart into the operating room, she struck the dorsum of her right hand against the wooden casing of a door, the hand being forcibly jammed between the casing and the cart. The palm of the hand was struck obliquely. The hand was ecchymotic and the dorsum of hand abraded. A week later, a swelling was seen in the palm of the hand, which became more noticeable when the index finger was moved. This swelling gradually became larger. Pain was inconstant and dull at first, but became sharper, when the thumb and index finger gripped something. In January, 1935, she did a great deal of writing during her examinations as a student nurse. Dull ache now became quite constant. It was localized both to the palm and dorsum of the hand, and pain radiated up the extensor side of the forearm, not only from the area of palmar swelling, but also from the region of the first dorsal interosseous space. It was made worse by certain motions of the hand in writing, sewing, typing, and on certain gripping movements. Rainy weather, the period just before change of weather, and the few days preceding her menstrual period, increased the intensity of pain. The hand often felt fatigued. Sometimes, the fingers felt stiff, and on some mornings, they were kept in slight flexion at the interphalangeal joints and in slight extension at the metacarpophalangeal joints. The wrist, too, felt weak. Pressure over the wrist produced sharp pain, radiating up the arm, and even to the shoulder.

The left hand also became painful, duplicating to a lesser degree the symptomalogy of the right hand. This followed the splinting of the right hand after operation and seemed due to the necessarily increased use of the left hand during that time. A similar, but smaller swelling, was noted in the left palm.

The right palm showed a soft, elliptical, and nonfluctuant swelling, one inch long and three-eighths inch wide, placed radially to the line of the tendons of the index finger and just within the thenar crease. It did not contain fluid and its aspiration gave none. The mass followed the line of the first lumbrical muscle.

She felt strain of her hand when the index finger was put into the intrinsic position, and the swelling became larger. When the finger was put into intrinsic radial abduction there was a greater feeling of strain. Motion of the index finger was free and noncrepitant. The mass did not increase in size on common flexion and extension of the finger. When the index finger was flexed at its three joints, attempted extension of the finger in maintained metacarpophalangeal joint flexion, gave her dull pain in the line of the flexor tendons of the index finger. She had no pain when the metacarpophalangeal joint was extended as the finger was extended.

A tender point was present in the distal palmar crease of the fourth and fifth fingers. The insertion of the adductors transversus and obliquus was tender both dorsally and palmarly on deep palpation. The first dorsal interosseous muscle was diffusely tender, especially near its origin from the base of the second metacarpal bone. The mid-part of the web of the thumb was tender.

The right hand measured 8½ inches in the area of swelling, the left 8 inches.

The right wrist was tender and crepitant over the region of the insertion of the extensors carpi radialis longior and brevior.

The palm of the left hand was similarly swollen, but the hand was only slightly painful and tender. The flexor tendons of the index finger creaked a little on motion of that finger.

Roentgenograms of the right hand were negative.

The postoperative therapy which proved effective for relief of pain was the repeated injection of 2 cc. of 1 per cent novocain and 0.2 cc. of 70 per cent alcohol dorsally into the area of adductor insertion, injections being given once weekly over a two-month period from March to June, 1936. Overuse of the hand brought about some recurrence of pain. The swelling in the palm remained unchanged.

The patient has a previously unnoted, bilateral, probably congenital hypertrophy of the first lumbrical muscle. The normal first lumbrical muscle is larger than the other three, but it is usually never more than a slender mass of muscle. It is doubtful if the injury created hypertrophy of this lumbrical muscle, but it did cause strain of this muscle, which was aggravated by the excessive use of the thumb and index finger in writing and sewing.

The first dorsal interosseous muscle and adductors of the thumb also received part of the primary trauma. Injury of the first lumbrical muscle may create a strain of the first dorsal interosseous muscle, since both muscles flex the metacarpophalangeal joint of the index finger and extend its proximal and distal interphalangeal joints. Strain of the first dorsal interosseous muscle is also reflected in adductor muscle strain, since both are adductors of the thumb. The primary effect of injury may have been upon the first dorsal interosseous muscle with secondary strain of the first lumbrical muscle. It is, however, more likely that both the adductor mechanism of the thumb and the first lumbrical were hurt at the same time.

CONGENITAL ANOMALIES OF THE LUMBRICAL MUSCLES

A study of congenital anomalies of the lumbrical muscles was made because the case of congenital hypertrophy of the first lumbrical muscle indicated that such anomaly might be clinically significant. Anatomical variation in the number and form of these muscles is sometimes seen.

Example. The dissection of the left hand of a middle-aged negro cadaver showed a supernumerary first lumbrical muscle with antibrachial origin, an anomaly absent in the right hand. It was placed radially to the normal first lumbrical muscle, beginning in the forearm by a thin fleshy belly which merged with the fleshy part of the flexor sublimis digitorum of the index finger. The muscle belly ended in a thin tendon, placed radially to the flexor sublimis tendon of the index finger about 4 inches above the wrist joint. The tendon in turn ended in a slender muscle fasiculus 2 inches long and ¼ inch wide just above the wrist joint. The fasiculus, passing through the tendinous compartment of the wrist, glided freely in its channel without adhesion to adjoining tendons. It ended in the palm in a thin, silvery,

tendinous thread about 2½ inches long, which inserted on the extensor aponeurosis of the first phalanx of the index finger proximal to the insertion point of the normal first lumbrical muscle and anterior to the termination of the tendon of the first dorsal interosseous muscle.

Review shows few references to anomalies of the lumbrical muscles but some of the textbooks note that variations in number of the lumbrical muscles are not uncommon. Macalister pointed out that the lumbrical muscles varied frequently in their origin by the addition of occasional heads of origin from neighboring tendons. The third lumbrical muscle is more often the site of such variation and he saw two irregularities of that muscle for every instance of variation in the other muscles. A series of six cases of anomalies of the first lumbrical muscle observed over a period of thirty years was reported by Gruber. In three of these cases, double first lumbrical muscles were seen, the extra one arising from the volar carpal ligament. Re-enforcement of the normal first lumbrical muscle by a belly or tendon from the flexor longus pollicis or from the superficial flexor tendon or replacement of the first lumbrical muscle by bellies from these origins has been reported.

The antibrachial origin of a supernumerary first lumbrical muscle has been described by Wood (1868), Macalister (1872), Bellini (1892), and Ledouble. The antibrachial origin of the second and third lumbrical muscles was reported by Dambrin (1930).[42–49]

PARALYSIS OF THE INTRINSIC MUSCLES—THE CLAW HAND

The fingers are hyperextended at the metacarpophalangeal joints and flexed at the interphalangeal joints when clawed. The wrist is usually palmarly flexed. The cause of deformity is *paralysis* or *weakness* of the balancing lumbricals and interossei. The deformity is more usually seen in the paralytic hand of poliomyeletis, ulnar nerve palsy, and other neurological lesions. It is a transient or dissociated lesion in spastic paralysis, especially, in the athetoid hand. It is also seen in the arthritic hand and in the hand clawed by ischemic contracture. Clawing is favored by palmar flexion of the wrist, and the kinetics of this mechanism has been analyzed by Steindler. When the wrist is fixed in palmar flexion, the claw hand may follow by stretching (passive insufficiency) of the common extensor tendons. The metacarpophalangeal joints are placed at a central point in the lever whose power is derived from the extensor muscles. It therefore hyperextends more easily than the other phalangeal joints.

It is not ordinarily possible to extend the distal two phalanges of a finger fully, when the first phalanx is maintained in complete hyperextension. The effort to do so causes strain of the stretched flexor sublimis tendon. The maximally stretched flexor sublimis tendon resists the effort at full extension. The distal two phalanges can only extend when the metacarpophalangeal joint is not hyperextended and the movement is more easily carried out in extension or slight flexion of this joint. The paralysis of the intrinsic muscles may then only be apparent and not real when the finger is clawed, unless intrinsic extension is tested in extension or slight flexion of the metacarpophalangeal joint.

The operative procedures may attempt rebalancing by reconstruction of a lumbrical, using a whole or part of a flexor tendon, or it may place the proximal phalanx in advantageous flexion by stripping of the collateral ligaments or by a sling operation.

The claw hand which is not yet fixed in contracture may be corrected by an attempted rebalancing operation, especially in ulnar nerve palsy. In infantile paralysis, the flexor muscles may also be paralyzed and hence not available for transplantation.

Each case is an individual problem. It is of course not always necessary to restore intrinsic extension and the hand may be useful, given good finger flexion. In one operation (Stiles operation according to

Lyle) the flexor sublimis tendon of the affected finger is freed, split longitudinally and each half transferred dorsally to the corresponding side of the extensor aponeurosis of the first phalanx. The Stiles operation according to Baldwin[14] is the dorsal transfer of the radially split third of the flexor profundus tendon. Bunnell's[8,40] modification of the Stiles operation passes the split sublimis tendon through the lumbrical canal with suture of the tendon to the dorsal surface of the transverse fibers and lateral band of the extensor aponeurosis.

It may be worth while to transfer the radial half of the flexor sublimis tendon to the dorsal aponeurosis. Silfverskiöld[12] transplanted the distal tendons of the flexor sublimis muscle dorsally to the extensor aponeurosis just distal to the metacarpophalangeal joint with good result in a case of ulnar nerve palsy.

Potter's operation[50] stabilizes the metacarpophalangeal joint by opposing the action of the long extensor and flexor sublimis digitorum. He noted that when the first phalanx was held, the finger could not claw. The paralyzed deep flexor tendon is sectioned transversely proximal to the proximal interphalangeal joint, split lengthwise, passed dorsally beneath the superficial flexor tendon, and sutured to itself. A sling was made preventing the hyperextension of the metacarpophalangeal joint. The distal half of the deep flexor tendon is split to increase tendon length. Each strip is passed dorsally over the middle phalanx, sutured to its fellow, and the proximal end is joined to the common extensor tendon to give active extension of the distal two phalanges. No cases were reported but the author claimed satisfactory results in a limited number of cases done soon after the end of the first World War.

When extension contracture of the metacarpophalangeal joint is present, it may be released by the distal stripping of the collateral ligaments of this joint, an operation described by Shaw[51] in 1920. The long sustained and unopposed extension or hyperextension position of the metacarpophalangeal joints finally leads to contracture, with resultant limitation of flexion, both actively and passively.

The operation serves a triple purpose, but only if the finger flexors show power. It gives a better looking hand, it relieves the hyperextension contracture, and it allows a certain amount of active flexion in the operated metacarpophalangeal joint through indirect and long arm leverage of the finger flexors. The hand may be closed to greater or lesser degree. The Shaw operation does not in any way substitute for the paralyzed interossei and lumbricals. The wrist must be in dorsiflexion before the operation is done. The drop wrist must first be arthrodesed to avoid recurrence of finger deformity, for the palmarly flexed wrist conditions the claw hand.

Dr. Harry Sonnenschein and I used this operation for the relief of the hyperextension contracture of the metacarpophalangeal joints in two cases of the (infantile) paralytic claw hand, two cases of nerve palsy, and one arthritic hand. The operation has not been previously used in the surgery of the paralytic hand. It has been used in traumatic fibrous ankylosis of the metacarpophalangeal joints, Koch[52] reporting his results with this operation. Manipulation of the metacarpophalangeal joints is not satisfactory and the joint may subluxate before the collateral ligaments give. Shaw, however, believed these ligaments could be freed by manipulation.

Each ligament is a lateral re-enforcing band in the thin capsule of the joint. The course of each collateral ligament is oblique, from dorsal and proximal to palmar and distal. Its point of attachment on the metacarpal bone is marked by a little bony prominence. They are relaxed in extension to allow lateral mobility of the joint; in flexion, however, they become taut so that lateral mobility is lessened. The collateral ligament can be sectioned and stripped without opening the joint capsule.

The operation is then indicated in the contracted claw hand, if the wrist can be maintained in dorsiflexion, and if there is active flexion power of the fingers.

OPERATIVE TECHNIC

Five dorsal longitudinal incisions are used, each about 1 inch long. Each begins about ½ inch proximal to the knuckle and extends distally to the lateral aspect of the base of the proximal phalanx. The incisions between webs serve for adjacent fingers. It is necessary to section the conjoined extensor tendons and the proximal part of the extensor aponeurosis of the finger. After retraction of the extensor tendon on one side and the atrophic belly of the interosseous muscle on the other, the metacarpophalangeal joint and its collateral ligaments are exposed. The collateral ligaments are variously developed. The individual ligament in contracture is a thick, narrow, oblique band. It is sectioned transversely at its metacarpal attachment just behind the metacarpal head and stripped distally. Much of the deformity is overcome after section of one collateral ligament, but both must be cut for full correction. If only one side is stripped, there may be snapping back of the finger into lesser extension at the metacarpophalangeal joint or lateral deviation of finger to the side of the uncut ligament. The hand is splinted in flexion by plaster or by banjo splint traction. Physiotherapy limbers the fingers and increases the grasp of the hand.

Shaw's technic seems simpler. An incision, 1.8 to 2.5 cm. long, was made on the side of the extensor tendon, and the metacarpal bone near the metacarpophalangeal joint exposed. The periosteum was raised forward and distally till the proximal attachment of the ligament was seen. It was divided and stripped with the periosteum.

The operation was once modified in that the dorsal capsule with its collateral ligaments was stripped distally from its metacarpal insertion.

Kofman[53] recommended osteotomy of the metacarpal for the correction of the "main en griffe."

Case xv. Nicholas Z., a boy of seven, had a flail left upper extremity as a sequel of infantile paralysis. The wrist was flexed to 100° and deviated ulnarly 70°. He was able to extend the wrist by action of the extensor carpi ulnaris. He had a typical paralytic claw hand. There was a fair degree of power in the flexors of the fingers.

Stripping of the collateral ligaments of the metacarpophalangeal joint was done on January 15, 1936. Arthrodesis of the shoulder was done on February 5, 1936. A transplantation of the tendon of the extensor carpi ulnaris to the paralyzed tendons of the extensors carpi radialis longior et brevior was done on March 31, 1937. He was last examined on September 26, 1941. The arthrodesis of the shoulder was solid. He was able to dorsiflex the wrist against some resistance in ulnar deviation by action of the transplant. The hand was useful for grasping and he was quite satisfied with the result of the Shaw operation. The hand was not clawed and active flexion of the metacarpophalangeal joints was to 150°. The most interesting thing was a return of extension power to the distal two phalanges of the fingers. He was able to extend these phalanges when the fingers were flexed and he could extend the fingers at all three joints. A Bunnell operation failed to give opposition of the thumb and its revision was advised.

Case xvi. Emily R., a colored girl of eleven, has a flail paralytic left upper extremity. On September 28, 1932, arthrodesis of the left shoulder was done, which was revised on November 15, 1933. A flexor plasty of the elbow was done on April 5, 1933. The wrist was fused on June 27, 1934. A transplant of the flexor carpi ulnaris to the common extensors was done at the same time. The wrist was fused at 180°, but increasing radial deviation developed because a bone graft, used in the fusion, interrupted the growth of the lower radial epiphysis radially. These epiphyses were later ablated.

The paralysis of the intrinsic muscles of the hand with extension stiffness of the metacarpophalangeal joints indicated the stripping of the collateral ligaments. Finger flexor power was good. She had a flat hand. The release of the

collateral ligaments was done on June 19, 1935 by Dr. Harry Sonnenschein through three incisions, instead of five. These were made along the lateral aspects of the metacarpophalangeal joints of the index, middle, and ring finger.

She was last seen on July 25, 1941. The wrist was solidly fused in some radial deviation. The forearm was pronated. The thumb could not be opposed and its carpometacarpal joint was contracted dorsally. She could bring the thumb to the middle finger by pseudo-adduction movement.

The result of the Shaw operation is satisfactory to the patient. She is able to hold things much better than before operation. In the resting position, the fingers are held at 175° of flexion at the metacarpophalangeal joints but active flexion is only possible to 165°. Active extension was possible to 235°.

The follow-up in these two patients is five and one-half years and six years, and in both the result is good.

The two patients with nerve lesions are both adults and the follow-up is not as long.

Case XVII. The first patient, a woman of thirty-seven, had a bullet injury of the medial side of her left arm in 1929, resulting in median and ulnar nerve injury. A postoperative sensory defect (after laminectomy for causalgia) exists in the distribution of the eighth cervical and first dorsal roots.

She had a flat hand with fixed clawing of the fingers. The wrist had good power of dorsiflexion. On September 7, 1939, the collateral ligaments of the index and middle fingers were released. The ring and little fingers were manipulated into flexion. The deformity recurred and the point was raised whether recurrence was unavoidable because of the lack of balance of the hand. This is the defect of the operation, that it does not restore intrinsic power. It was believed, however, that, if the operation had proved itself of value in the poliomyelitic hand, it would be of value again, the development of fibrous ankylosis in some flexion mitigating against recurrence of extension contracture. On March 13, 1941, the operation was revised, the collateral ligaments of all the fingers, except the ulnar one of the little finger being sectioned and stripped distally. The dorsal capsule of each joint was opened in each finger during the stripping.

The fingers are now in slight flexion and are more advantageously placed for grasping. She expresses herself as fairly well satisfied. It is interesting that the little finger shows an abduction position of almost 35°, due to the fact that its ulnar collateral ligament was not stripped.

A Bunnell operation was done on April 18, 1940, together with release of the dorsally contracted capsule of the carpometacarpal joint of the thumb. After the revision of the Shaw operation, the ability to move the thumb across the palm receded and is being slowly regained. It is, therefore, advisable that reconstructive work on the thumb be postponed till after finger correction.

Case XVIII. The second patient, a man of thirty-three, had a palsy of the ulnar nerve and of the posterior interosseous after a bullet wound of the left forearm in 1938. On January 11, 1939, suture of the ulnar nerve was done with some return of sensation. The posterior interosseous nerve was cut below the level of the supinator brevis and its repair was inadvisable. Wrist extension was weak and an extension contracture of the metacarpophalangeal joints existed by passive stretching of the paralyzed common extensor tendons. A fusion of the left wrist was done on April 6, 1939.

The extension contracture of the middle, ring, and little fingers was released on March 14, 1940, and of the thumb and index finger on June 13, 1940.

An effort was made to limber the metacarpophalangeal joints before this operation but some fibrous stiffness persisted in flexion. On May 12, 1941, the extensor carpi radialis and ulnaris were transplanted into the common extensor tendons of the fingers, and the flexor carpi ulnaris into the extensor brevis pollicis. The extensor tendons of the little finger and ring finger were adherent to the metacarpophalangeal joint and displaced a little ulnarly. Pull of these tendons did not extend these fingers. (It would seem that the Shaw operation would tend to make an extensor transplant less effective.)

Two years after the Shaw operation, the fingers were held in flexion at the metacarpophalangeal joint. He could not extend them. He could grasp objects strongly and felt that the operation had helped him a good deal.

Fibrous stiffness of the metacarpophalangeal joints in arthritics limits flexion of the fingers

at these joints. The disability is an extension contracture which is corrected by the stripping of the collateral ligaments.

Case XIX. Rosa B., a woman of forty-five, was first admitted on September 23, 1935, for manipulation of an arthritic right shoulder. The arthritic right hand was manipulated on September 9, 1936, with no improvement. The metacarpophalangeal joints of the right hand showed marked limitation of flexion. There was also limitation of flexion at the interphalangeal joint. The thumb could be opposed only to the index finger because of an adduction contracture of the thumb. Motions of the right wrist were possible from 180° to 160°. On September 16, 1936, the stripping of the collateral ligaments of the affected metacarpophalangeal joints was done. The postoperative course was uneventful.

This patient has been examined periodically in the clinic, the last note pertaining to her hand being made on September 11, 1937: The function of the hand is improved and it is possible to flex the fingers at the metacarpophalangeal joints more than before, although she cannot make a full fist, because of arthritis of the distal interphalangeal joints. The result of this operation can be considered good.

ROTATION OF A FINGER

There is no kinesiological mechanism permitting rotation of a finger. The normal finger can be passively rotated a few degrees but active rotation is not possible. The movement is a rotary one of the whole finger on its relatively fixed metacarpal.

Shaw noted rotation of a finger after division of one collateral ligament of its metacarpophalangeal joint. Radial rotation of the left middle finger of a negro adult followed an oblique fracture of the base of its proximal phalanx, the fracture line running from proximal and ulnar to distal and radial.

COMBINED LACERATION OF THE TENDONS OF INSERTION OF THE LUMBRICAL AND INTEROSSEOUS MUSCLES

Laceration of the tendon of insertion of a lumbrical muscle seems uncommon, but is quite likely that it is missed in the usual examination of the hand which does not concern itself with the intrinsic muscles of the hand. It must be thought of in associated lateral imbalance, when the tendon of insertion of an interosseous muscle is cut. Usually, both tendons of insertion are cut, either by a direct lacerating trauma or by an improperly placed operative incision. The radial digital nerve may also be cut at the same time. An accurate anatomic diagnosis can be made so that the operative findings may be foretold for proper operative procedure, which is suture in the intrinsic functional position.

Usually, the first lumbrical and first dorsal interosseous tendons of insertion are cut because of their more exposed position on the radial side of the index finger. The direction of incision or cut is more easily an oblique one, which runs from radially and distally to ulnarly and proximally at the base of a finger. Three such cases have been examined.

Other possible combinations, given a cut or incision running similarly at the base of the other fingers are: the second lumbrical and second dorsal interosseous muscles, the third lumbrical and second volar interosseous muscles, the fourth lumbrical and the third volar interosseous muscles.

If the cut or incision runs in opposite direction at the base of a finger, the lumbrical tendon may be missed since it inserts radially. The intrinsic muscles which may be singly cut are: the first volar interosseous muscle, the third dorsal interosseous muscle, the fourth dorsal interosseous muscle, and the hypothenar muscles.

DISABILITY IN FINGER FLEXION

Disability in finger flexion constitutes a most important chapter in hand disability. Its broadest aspects are only considered in this study and reference to medical literature will disclose a multitude of excellent papers on each individual condition and its treatment.

In general, flexion disability may be put into two categories of disability: The inability to open the hand is caused by flexor

contracture or extensor weakness, while the inability to close the hand is due to extensor contracture or flexor weakness.

Flexion contracture is extratendinous as in Dupuytren's contracture, tendinous as after old laceration or infection of the flexor tendons, or muscular, as in the flexor muscle shortening of ischemic contracture and spastic contracture. The paralytic claw hand may show flexion contracture of its interphalangeal joints. Flexion contracture of the arthritic hand is either myositic, articular, or tendinous. All cause greater or lesser disability in hand opening.

When the affected finger is flexed at its metacarpophalangeal joint, extension of the adjacent fingers becomes automatically restricted, and this extension inability diminishes progressively in the fingers furthest away from the bent finger. The reverse is also true, that extension of a finger at its metacarpophalangeal joint automatically restricts flexion of the adjacent fingers, this restriction being least in the fingers furthest away from the extended finger. This point is worthy noting in Dupuytren's contracture and in other contractures in which the finger is flexed at its metacarpophalangeal joint.

Not infrequently in spastic and in ischemic contracture, the fingers become flexed at their interphalangeal joints, when the wrist is dorsiflexed because the flexor muscle bellies are shortened. This flexion is released by palmar flexion of the wrist. Secondary hyperextension of the metacarpophalangeal joints may follow. The Jones method stretches the shortened muscles by gradually extending the wrist, the fingers being held straight. Localized ischemic contracture is seldom seen.

The inability to close the hand by flexor weakness may be due to inflammation of the flexor tendons, recent or old laceration of these tendons, their paralysis as in infantile paralysis and median nerve paralysis.

After laceration of a finger flexor tendon, the finger flexes by interosseous muscle action only at its metacarpophalangeal joint. Extensor contracture as by scar contracture with adherence of the extensor tendons restricts finger closing.

FLEXOR SUBLIMIS—FLEXOR PROFUNDUS DISSOCIATION BY SUBCUTANEOUS RUPTURE OF THE FLEXOR PROFUNDUS TENDON

It is normal that when one flexor tendon of a finger is injured, the other is also injured. Dissociation of power in favor of the sublimis flexor is quite uncommon.

Case xx. The patient, a man of twenty-six, fell on the tip of the right ring finger on July 14, 1940. Since then, he had been unable to bend the distal phalanx of the finger.

The distal joint was held in 2° to 3° of flexion. The joint could be passively flexed fully but there was no active flexion. Extension was fairly strong and there was an extensor rebound. The proximal joint flexed to 80° actively and extended to 180°. The metacarpophalangeal joint flexed completely but hyperextension was only 10°. The finger could not be clawed as well as its neighbors. Tenderness was present over the anterior and proximal crease of the base of the finger. Intrinsic motions were good. In making a fist, the distal joint did not enter into the palm. The grip was weaker than it had been. A roentgenogram showed an old healed chip fracture of the anterior aspect of the base of the distal phalanx by tendinous pull.

The finger showed no flexor variant deformity. There was isolated dysfunction of the flexor profundus. This was proved operatively, the adherent tendon having been torn obliqually.

An interesting observation is the inability to claw the finger well. When the normal finger is clawed, the flexor sublimis tendon is stretched, and first the proximal joint and then the distal joint go into flexion. If, for any reason the flexor tendons cannot stretch, as by adhesion of one or both flexor tendons, it becomes difficult to hyperextend the strained metacarpophalangeal joint. It is hard to claw the normal finger when its distal joint is held extended.

NARROWED HAND

Two instances of narrowing of the hand were seen. It is a deformity of the hand

created by a gross disproportion of the radial half or border of the hand (second and third metacarpals) and ulnar border of the hand (fourth and fifth metacarpals). The radial half of the narrowed hand was relatively flattened in a man with dorsal dislocation of the bases of the fourth and fifth metacarpals. In a woman of thirty-nine, whose right wrist was fused for tuberculosis nine years before examination, there was flattening of the dorso-ulnar part of the hand with volar dropping of the knuckles of the fourth and fifth fingers. The index and middle fingers diverged widely from the other fingers. In both cases there was disturbance in finger function.

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STEREOSCOPIC PHOTOGRAPHY FOR SURGICAL MOTION PICTURES*

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STEREOSCOPY is the science of creating an illusion of depth or three dimensions in a picture by binocular means. The principles of stereoscopic photography, for both still and moving pictures, have been known for a long time but only recent developments permit their practical application with relative ease. For instance, it is now possible to present, to a large audience, a full size motion picture in natural colors and three dimensions. Such pictures have been used for advertising and educational purposes. We believe that we are the first to employ this medium for recording the technic of surgical procedures. The following discussion concerns the latter application.

ADVANTAGES

Before discussing the subject at length, it might be well to review what advantages, if any, one has the right to expect of stereoscopic motion pictures made in the operating room. Few will deny the benefits resulting from the illusion of a plastic picture; that is, a picture that stands out in relief and in which spacial positions are readily portrayed in each of the three directions. In education the plastic picture can illustrate more clearly than can a flat picture. In surgery the plastic image shows definite spacial relations between various tissues, organs, and other anatomical parts, and illustrates the movements of the surgeon's hands and instruments realistically and clearly.

It is not so well known that a stereoscopic picture can more accurately render surface texture. In a flat picture all the large and small highlights situated here and there on each shiny curved surface are fixed in position and appear to be in the same place for each eye. In a stereoscopic picture, however, these highlights are unbounded and are free to occupy positions different for the left eye than the right eye —a natural situation. The two dimensional blotches representing highlights seem to shift away, leaving the surface more clearly visible. In surgery, in which the subject matter may consist largely of moist curved surfaces, the advantage of stereoscopy is apparent.

An additional, though perhaps minor, advantage results from the reduction of the obstructing tendency of objects interposed between the cameras and the object. The surgeon has every right to place his hands in the field of view when he is performing an operation, but only those who have attempted photography of an operation while it is in progress appreciate the difficulty of securing a satisfactorily clear field for both camera and the doctor simultaneously. Since, in stereoscopic photography, the scene is being photographed at all times from two separate viewpoints, there is naturally a small but valuable reduction in the percentage of time that the field of view is obscured.

Small sized films when enlarged greatly, sometime show the grain structure of the emulsion. When the films are viewed stereoscopically, however, the grain pattern is not the same for the left and right eyes and visibility of the grain is greatly reduced. At the same time an apparent increase in definition is realized, which improvement

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is noticeable even with Kodachrome film, although Kodachrome has no visible grain. Even with the best of care, motion picture films accumulate some dust, dirt, scratches and other blemishes during their lifetime. Since any particular blemish will appear before only one eye, it follows that in stereoscopic viewing the effect of blemishes is reduced and the film life is increased.

STEREOSCOPIC TECHNIC

The technic of stereophotography and the presentation of stereophotographs present two separate problems: The first requires the exposure of two photographs simultaneously, from viewpoints separated by a distance that would correspond in a rough way to the separation between the human eyes, i.e., the interpupillary distance. The second requires the viewing of these two pictures simultaneously in such a way that they are apparently closely superimposed, yet at the same time the left eye must see only the picture taken from the left hand position and the right eye only the picture taken from the right hand position.

There are many known ways of taking such pictures, but in general these may be divided into two classes, the single system and the double system. In the single system the two pictures are exposed on the same film. In the double system, separate films are used, sometimes in two separate cameras, sometimes in a special single camera with two lenses. The well known beam splitter suitably centered in front of nearly any camera will convert that camera into a single system stereocamera. But this simplest of all stereocameras has several disadvantages: the film area is reduced, the field of view is reduced for a given lens, the frame becomes an unfortunate shape, there is light loss at the image, centering is difficult, fast lens are more difficult to accommodate without blurring in the central regions, and certain distortions appear. Until commercial equipment to meet particular requirements becomes available, the double system is the most practical for serious work in stereoscopic motion pictures. This is true because standard cameras and projectors of high quality can be linked together in pairs with a minimum of mechanical alteration, and the resulting equipment will be able to meet most requirements satisfactorily.

Two films of exactly the same length are exposed at once in the two cameras. Each film is exactly standard in all respects and each includes the same view of the operative field. Either length can be projected alone in any suitable standard projector and in case one should become damaged or destroyed, a complete record would still exist in the other. Moreover the two can be projected together with special equipment mentioned below in such a way that a full three dimensional or stereoscopic scene results.

It is possible, of course, for one person at a time to view the stereoscopic movies with special equipment much after the method of the old-fashioned stereoscope that a few generations ago was found in the parlor of any well appointed household. Far more satisfactory, however, is the projection of the motion pictures upon a full sized screen to be viewed simultaneously by a relatively large group of people. Such projection has recently become practical through the development by the Polaroid Corporation of methods of manufacturing large thin sheets of polarizing material. Such material placed with the proper orientation before two projectors and before each eye of each individual in an audience can satisfactorily meet the requirements mentioned above for selective viewing of the images for the left and right eye. Moreover, satisfactory polaroid viewing devices are available for as little as a few cents each.

EQUIPMENT FOR STEREOPHOTOGRAPHY

Having established our technic for stereoscopic motion pictures, we will discuss in more detail the making and the projecting of such pictures.

Any film width satisfactory for ordinary motion pictures is suitable for stereoscopic

motion pictures and the authors have experimented with 8 mm. and 16 mm. The standard 16 mm. width is to be preferred over 8 mm. or 35 mm. for surgical work because (1) it is readily available in Kodachrome as well as in black and white; (2) when exposed on good equipment, it has ample definition for most requirements; (3) sufficient light intensity can be obtained for satisfactory projection to audiences of several hundred people; (4) film cost is considerably less than that of 35 mm. film; (5) the depth of field, while not as great as on 8 mm. film is not a serious handicap even under unfavorable lighting conditions and is greater than that on 35 mm.; (6) all 16 mm. film is safety base; (7) when the twin projectors are not available, either of the two films may be shown individually on any standard projector; (8) the cost of the 16 mm. film is considerably less than for 35 mm. film.

The best results are not obtainable in any photographic work without excellent equipment maintained in excellent condition. Several manufacturers make suitable equipment for a stereoscopic adaptation and the Eastman magazine loading cameras shown in Figure 1 are but an example.

Two cameras are required. Services of a good mechanic must be obtained for the purpose of constructing suitable shafts for coupling so that the two cameras may be located side by side and operated at exactly the same speed. Synchronism can be achieved electrically or mechanically. If mechanical, the coupling must be flexible enough to permit variation of the angle between the cameras. Synchronism must be accurate to a small fraction of one frame. Backlash of coupling should not be more than 5 or 10 degrees, measured on a single frame shaft. It is easy to maintain this small backlash angle with mechanical coupling but electrical synchronization offers the advantage of versatility in camera positioning. The authors used the mechanical form of coupling.

In some cases it is desirable that the distance between cameras be adjustable; for long shots the cameras should be moved farther apart, and for closeups, closer together. Alternately, closeups can be secured with longer focal length lenses from a distance, without adjusting the cameras so close together. The photography of surgery should be in closeups when possible and a small camera interspace is generally indicated, since the thickness of the individual cameras limits the available proximity. It is believed that adjustment of the distance between cameras is unnecessary in surgery, and recourse to telephoto lenses is imperative.

A mounting jig must be made to meet the following requirements: It should permit rapid and easy mounting and removal of the cameras. When mounted the cameras should be accurately and consistently aligned, and the correct spacing for the synchronizing shaft should be maintained. If one camera obstructs the loading function of the other, provision should be made for swinging the one out of the way. Finally, there should be an adjustment to permit the cameras to be toed in so that the optical centers can be caused to converge at various distances into the field of view. There should be a scale attached in such fashion that the distance can be set as required, according to the technic recommended below.

Figure 1 shows the magazine Cine Kodaks mounted in the jig and synchronized ready to take pictures. In Figure 2 is shown the mounting jig which is one of many possible designs. The right camera is attached at (A) by means of a screw into its tripod bushing, and the left camera at (B). (C) is a pivot to permit the left camera to be lifted out of the way when the right camera is being loaded with a magazine. When the left camera is swung back in place, its alignment is automatically re-established. The coupling shaft separates when this function is being performed. At (D) is a scale for the purpose of adjusting the angle between the cameras, much as a camera lens is focussed. This adjustment is permitted by the pivot (E). The center of the flexible coupling is

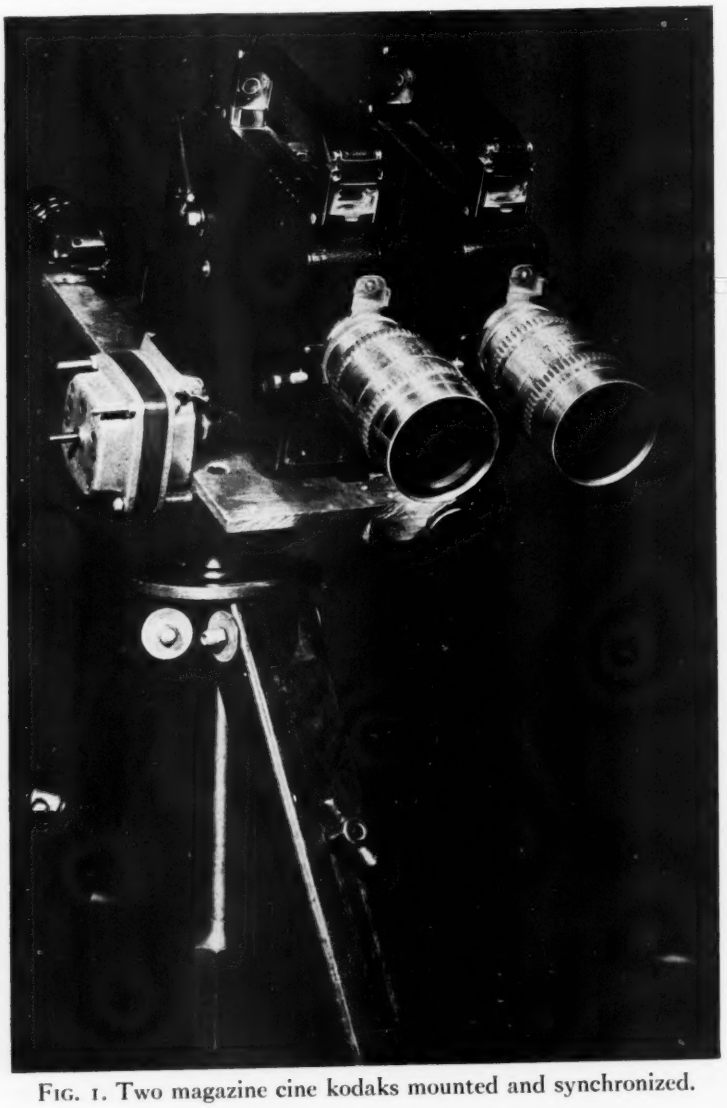

FIG. 1. Two magazine cine kodaks mounted and synchronized.

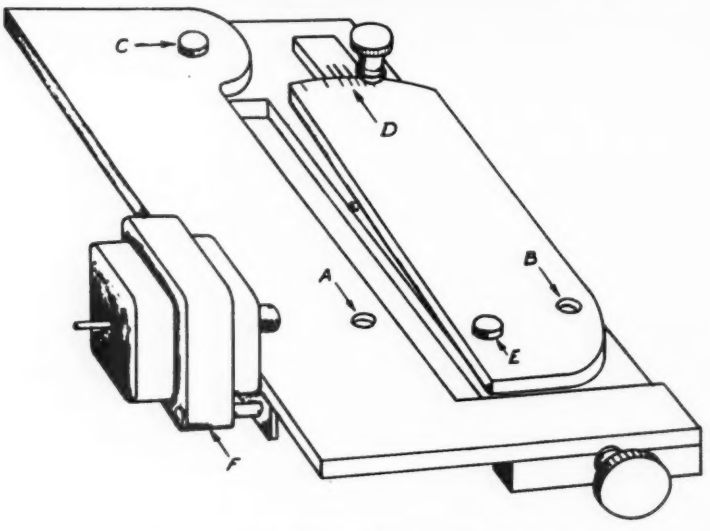

FIG. 2. Mounting jig for stereoscopic cameras.

located on the axis of (E) to prevent stretching of the shaft when the angle is being adjusted. (F) is a non-sparking motor used to drive both cameras.

The photographic principles regarding composition, lighting, angles, etc., apply to stereoscopic photography much as they do to flat photography. It can be claimed, however, that lighting is of somewhat less importance in stereoscopic photography. A photographer taking a flat picture will, if he can, skillfully adjust his lights to accentuate the illusion of depth. Such a procedure is not so necessary when the image as later viewed will automatically reveal its own depth. Color film has less latitude than black and white film and the lighting problem for accentuating depth in a flat picture taken in color is more difficult because of this low latitude. In general, Kodachrome must be exposed with relatively flat uncontrasting light. If the illusion of depth suffers because of flat lighting in ordinary colored pictures, one might expect to find stereoscopy even more beneficial to color film than to black and white. The illusion of depth whether secured by lighting as in a flat picture or by stereoscopic means, is naturally of artistic value and has in addition instructional merit, since in a mechanical sense, it tells a story more accurate and complete in detail.

The boundary of a stereoscopic image is controlled by the position of the boundaries of the left and right images and it may lie in a plane either nearer or farther than objects in the scene. Since the boundary is like a window through which the observer is viewing, it would be very unnatural for it to be beyond the scene. This is one of the reasons for the toe-in adjustment mentioned above. The optical axes of the cameras should be adjusted to converge in front of the main objects in the scene. This will cause the framing window to appear to be interposed between the viewer and the scene, not beyond the scene.

In order to avoid the necessity of continually adjusting the amount of overlap when the pictures are being viewed, it is desirable to adjust the cameras so that their optical axes converge a constant angular amount nearer than the principal object in the scene. This is accomplished by a fixed displacement of the pointer against which the scale is read. The magnitude of this displacement is not critical but it is best to keep it uniform for a given sequence. A satisfactory angular displacement may be around 5 degrees for the normal or one inch lenses. For greater or lesser focal length lenses, the angular displacement should be fractionated inversely as the focal length. Thus for two inch lenses the angle should be reduced by one-half, and for one-half inch lenses the angle should be doubled. Since manufacturing tolerance in the framing member of projectors may apparently disturb the relations mentioned above, it is sometimes desirable to find the best angles by experiment. The simplest method of calibrating the scale for lenses of several focal lengths is to use but one angular scale, calibrated in feet, and to read the scale on a separate index or pointer for each of the lenses to be used.

A few comments on motion picture photography in the operating room may be in order. The use of color film is to be recommended but lighting and exposure difficulties are greater than with black and white film. It is necessary to expose with light, the color temperature of which is suitable for the particular color film in use, as outdoor Kodachrome or Type A indoor Kodachrome. Since the indoor film is faster it is to be preferred over outdoor color film for nearly any work using artificial light. Indoor color film is color balanced for lamps operating at a color temperature of about 3400 K. This is approximately the color temperature of photo-flood lights when operated at their rated voltage. The usual operating room lights burn at a cooler temperature and with Type A film will produce results with an excessively red color balance unless suitable filters are placed either in front of the camera lenses or over the lights. Whenever practical,

photo-flood lights should be employed, Type A Kodachrome film with no filters.

The determination of exposure with Kodachrome is especially difficult in the operating room. The use of an ordinary meter is not practical, since the wound is usually small, recessed, and darker than the surrounding drapes. To bring the meter close enough to measure only the light reflected from the wound would be to endanger the patient. Special meters are available which will rate the intensity of a small field at some distance. Possibly a more practical exposure adjustment can be obtained by calibration of numbers of photo-floods against distance to the wound at some specified line voltage. A handy disc type of exposure calculator can easily be made for quick computation. The optical range finder common in photographic circles is probably the best method of establishing the distance from the lights to the wound. For results of the highest reliability, it is usually necessary to measure the line voltage supplying the photo-floods. Measurement should be made with the photo-floods turned on since as little as 5 per cent variation in line voltage can produce a noticeable change in exposure and color balance. Once the exposure has been established only minor changes need be made to allow for light or dark tissues, shallow or deep cavities as experience dictates. R 2 photo-floods have a great advantage over ordinary photo-floods because of sturdy glass construction, compactness and general serviceability. When photo-floods are used for long periods, allowance should be made for the slow decrease in effective light power caused by slight blackening of the inside of the glass. R 2 photo-floods may be as much as one lens stop weaker at the end of their rated life of six hours.

It should be mentioned that the amount of depth appearing in a stereoscopic picture is a function not only of the camera interspace, but of other parameters, such as the focal length of camera and projector lenses, the camera distance, projector distance, and viewing distance. In addition, psychological considerations are of importance. On the other hand there is considerable tolerance in viewing, so that the depth can be accentuated or reduced and the picture will still look reasonably natural. Evidence of this is the fact that a flat picture may look natural although it has no degree of stereoscopic depth at all. In general with a fixed interspace the closer the cameras are to the object the more is the accentuation of depth, and the use of normal lenses for detailed closeups would be objectionable if carried to the extreme. But closeups are very satisfactorily obtained with telephoto lenses from more remote camera distances.

EDITING OF STEREOSCOPIC MOTION PICTURE FILMS

The editing of double system stereoscopic films presents special problems because of the fact that the two films must be cut in exact synchronism to the nearest frame throughout the whole length of the production. Should either film become broken or damaged, or require splicing for any reason at any time, each film should be cut at exactly the same frame and the same splice made in each.

The first step in editing new film is synchronization of the left and right footage without any particular regard to continuity. Since surgical footage usually is made in the correct time sequence, not much shifting of scenes will be necessary if the original reels are linked in correct chronological sequence.

The next step is to view one of the films and to cue preliminary cutting by means of notches or perforations punched into the center or edge of the film.

The two films are then set up on two rewind spindles and are drawn together to the cue marks, where the two are cut simultaneously and respliced as required. Constant check on synchronization is easily had by inspecting the start or end of individual scenes.

Next, one film is again viewed and further cutting is cued, after which addi-

tional cutting is done on the two reels. The process is continued until the sequence and tempo are considered optimum and satisfactory.

In order to make it easy to start the two films in step-in projecting it is convenient to attach white leaders at exactly the same frame at the beginning of each film. Also it is desirable to attach 8 or 10 inches of black opaque leader between the white leaders and the live footage.

TITLES

Titles may be made in any conventional manner, with this exception: It is usually necessary to photograph titles with the same cameras and the same mounting jig that were used to photograph the balance of the footage. If this rule is not observed, alignment difficulty may be experienced when the titles appear on the screen.

PROJECTION EQUIPMENT

Since polarized light is at present the most practical and satisfactory method of projection to large audiences, no other method will be discussed here. It is most desirable that high quality projection equipment be used. If large audiences are to be accommodated, with the required large screen, powerful projection lamps should be available. Five hundred or 750 watt projectors of high quality are available on the market and should prove satisfactory.

Suitable synchronizing means must be provided, so that the projectors run at exactly the same speed. Electrical means can be employed, but where a transverse high speed shaft is available on the projectors a simple mechanical connection is to be preferred. This should contain one or two universal joints to permit alignment of the images on the screen. If desired, a mounting base or a jig is not essential.

Figure 3 shows a pair of Ampro modeal KD projectors with synchronizing shaft in position. The shaft is detachable by simply pulling it out and the projectors can be packed in their usual individual cases for carrying.

Polarizing filters are attached over the lenses of the projectors. They may be attached rigidly and permanently or they may be mounted on a hinged member to permit them to be swung out of the way when nonstereoscopic film is being projected. Probably the simplest mount for the polarizers consists of standard filter rings intended for use on camera lenses. When filters are mounted this way, however, it is necessary that the orientation of the filter be carefully adjusted and maintained, especially after focussing.

The polarizing filters on the two projectors should be mounted with their axes 90 degrees apart. In this country some workers in stereoscopy have mounted the right polarizer vertically and the left horizontally, but more recently a technic of upright v mounting has been favored. In any event, the orientation of the polarizers on the projectors must correspond to the orientation of the polarizers in the viewing devices to be distributed to the audience.

The proper functioning of the polarizing method of viewing projected stereoscopic pictures depends upon the property of polarized light which permits transmission through a polarizing screen when the orientation is favorable, but eliminates transmission when orientation is unfavorable. If the beam from the left projector, which carries the film which should be visible to the left eye, passes through a polarizer 45 degrees to the left of vertical, the left eye of the viewer should be shielded by a polarizing screen oriented similarly, whereas the right eye of the viewer should be covered with a polarizing screen oriented 45 degrees to the right of vertical. The polarizer covering the right eye will then obscure the picture projected by the left projector. Meanwhile, the light beam from the right projector, which carries the picture intended for the right eye, should pass through a polarizing screen oriented 45 degrees to the right of vertical. This picture will be visible to the right eye but

not to the left. Thus selective viewing of the respective pictures for the left and right eyes is obtained.

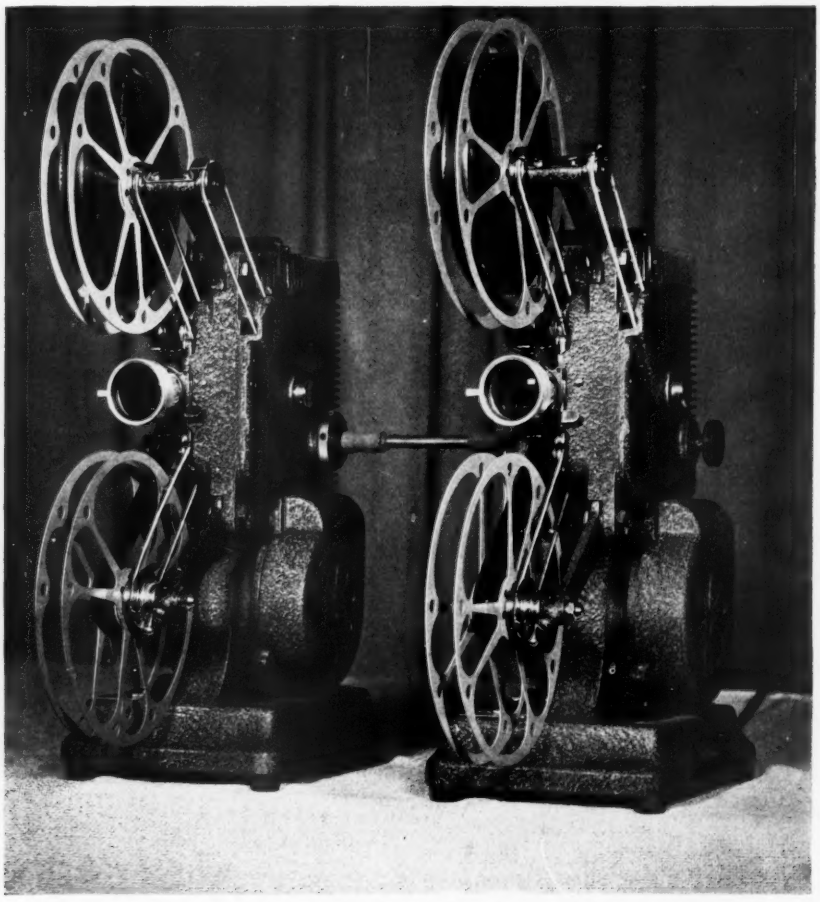

Fig. 3. Paired projectors with synchronizing shaft in position.

Choice of screen material is of importance. Many substances when illuminated with polarized light will reflect ordinary light and a screen made of such material would interfere with the functioning of the polarized viewing devices, so that each eye would see both images. The most satisfactory screen at present is probably a metallic surface such as aluminum. Aluminum for motion picture screens may possess rather poor diffusion characteristics which lead to a serious darkening of the image for persons attempting to view the pictures off to one side. To minimize this difficulty, the surface on which the aluminum is sprayed should not be too even, nor should the aluminum powder be too fine. In addition to the satisfactory polarized light characteristics, aluminum has the additional advantage of being highly reflecting. The polarizing viewing technic reduces the light to, perhaps, one-quarter of its normal value and the high reflectivity of the aluminum partially compensates for the loss.

PROJECTION

Except for the use of the special equipment discussed above, the projection of stereoscopic motion pictures is essentially the same as the projection of ordinary motion pictures. Large audiences can be accommodated and the equipment is portable and easy to set up. Polarized viewing spectacles must be used by every member of the audience. These must all have the same orientation, which must correspond to the orientation of the polarizing screens on the projectors.

Viewing from too far to one side will cause distortion in the stereoscopic image, just as in a flat picture. In placing the audience some consideration should be given to the diffusing capability of the screen material so that those off-center will not receive too dull an image.

It is well known that the perspective of a flat picture varies with the viewing distance. More striking is the variation in stereoscopic depth with viewing distance. The depth is least for persons near the screen, and may increase to tremendous proportions for those who may be twice or three times the projector distance. Although there is considerable tolerance in viewing, it is desirable to avoid placing anyone too close to the screen or too far away.

The images of the two projectors should be aligned as soon as they appear on the screen. Alignment can best be adjusted by viewing the screen without the aid of spectacles, when both images will be visible to each eye of the operator. The vertical alignment must be adjusted with great care, inasmuch as the eyes are most sensitive to error in the vertical angle; if the height of the two images should not be identical, suitable adjustment should be made to avoid eye strain. The lateral alignment or overlap is not so critical, because the human eye has more lateral tolerance than vertical. The projection masks should be adjusted so that they are of equal height on the screen. These masks will not ordinarily correspond laterally because of the toe-in of the cameras previously discussed.

When white leader is attached correspondingly to the left and right films as recommended above, synchronization at the time of threading is easily obtained by placing the splice at the end of the leader at the same position in the film gate of each projector. Synchronization will then be perfect for the duration of the footage projected, provided editing has been carefully carried out.

CONCLUSION

Stereoscopic motion pictures afford the natural method of viewing operative procedures, in other words, the visual effect obtained is exactly that of a two-eyed person watching the actual operation. As stereoscopic vision is natural for every individual with two good eyes, the advantages of stereoscopic motion pictures are obvious, particularly when immediate comparison is made with the customary flat or two-dimensional pictures. There is considerably less obstruction to vision by interposed hands and instruments, as the stereoscopic vision permits one to look around, so to speak, the intervening objects. Operations performed in deep body cavities are kept entirely in the field of vision with good focus, although care must be taken by the photographs not to exaggerate the depth. The greater detail and clearer vision of this method are useful in illustrating all operative technics even in flat surgical fields where the three dimensional effect is not so important, e.g., in neck dissection and thyroidectomy. It is our belief that stereoscopic motion pictures represent a distinct advance in the method of teaching operative technic. Examples of operations suitable for demonstration by this principle are the following: abdominoperineal rectal resection, partial and total gastrectomy, hysterectomy, right hemicolectomy, radical groin dissection, radical mastectomy, esophagectomy, pneumectomy, brain and intra-oral operations.

NEUROGENIC VESICAL DYSFUNCTION DUE TO SPINA BIFIDA AND MYELODYSPLASIA

TREATMENT BY TRANSURETHRAL RESECTION OF THE VESICAL NECK

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THE association of congenital abnormalities of the lumbosacral portion of the spinal column and sacral portion of the spinal cord with neurogenic vesical dysfunction has been known for many years and many investigators have contributed to our knowledge of this subject. Prominent among these are Virchow, who in 1875 was the first to employ the term spina bifida occulta, and Fuchs, who in 1909, in reporting a series of twenty-four cases of enuresis, was the first to employ the term myelodysplasia. Von Recklinghausen, in 1886, however, was the first to publish a really comprehensive discussion of this subject and Brickner, in 1918, the first to publish a large series of such cases. Subsequently others, particularly Chute, in 1921, Helmholz, in 1926, Campbell, in 1929, Mertz and Smith, in 1930, and Smith and Engel, in 1932, have published excellent articles on this subject as well as provided detailed reports of their respective series of cases.

That spina bifida occulta may be present without causing symptoms is well known. In fact, it is so common and so infrequently associated with symptoms that the suggestion has been made that it might be but a variation of the normal and not an anomaly. According to Woltman, "Roentgenologists believe that spina bifida occulta is so common that it may be considered a normal variation which has little or no bearing on the cause for which the patient is referred for examination." Mertz, among others, while of the opinion that spina bifida occulta seldom causes vesical dysfunction, nevertheless expressed the belief that such a lesion can, and occasionally does, affect the nerve supply of the bladder in such a manner as to interfere with its normal function. We are in accord with this point of view, granting that most cases of spina bifida occulta are without symptoms while acknowledging that in a small proportion of cases spina bifida occulta is probably the cause of the neurogenic vesical dysfunction. In our experience neurogenic vesical dysfunction is most likely to occur in those cases in which there is the most marked defect or greatest degree of deformity of the lumbosacral portion of the spinal column, and least likely to occur in those cases in which there are minimal defects. Exceptions to this rule, however, are fairly common. Occasionally, myelodysplasia of the cord may exist in the absence of any evidence of anomaly or deformity of the lumbosacral portion of the spinal column, but these cases are very uncommon. Woltman, in 1921, in his study of spina bifida, mentioned that it occurred only three times in his series of 187 cases.

CAUSATION

The manner of formation of spina bifida and other allied congenital anomalies of the lumbosacral portion of the spinal column is most interesting. According to Chute, "The bony defect of spina bifida is due to failure of the tissues of the mesoblast which forms the bony and muscular coverings of the cord to push in between the epiblastic tissues that form the spinal cord itself, and that part of the epiblast that forms the skin." The anomalous defect, once produced, results in the formation of abnormal spatial relationships

between the sacral portion of the cord and its nerves and the adjacent bony structures, and trauma to the cord and cauda equina may occur from undue traction or pressure on the structures of the cord. Frequently, in addition to the fusion defect of the osseous spinal column, there is a co-existing congenital or developmental defect of the sacral portion of the cord itself (myelodysplasia). Whatever be the lesion, however, whether a primary maldevelopment of the cord or secondary changes due to pressure or traction on the sacral nerve roots, the important consequence of the anomaly is a defective ("parasympathetic") innervation of the bladder.

There are many explanations offered of the disordered innervation of the bladder in these cases of congenital malformation of the lumbosacral portion of the spinal column. Elsberg, for instance, endeavored to explain the damage to the sacral nerve roots in cases of spina bifida occulta and spinal bifida cystica in somewhat the following manner: Ordinarily at the end of the third fetal month the cord extends down to the lower end of the spinal canal and as the individual grows the cord recedes until its lower end is about at the level of the first and second lumbar arch. If, therefore, the nerve roots are bound down to the lower end of the spinal column, as may occur should they be herniated through a dehiscence of the spinal column, they will undergo stretching as the disproportion of length between the bony and medullary columns develops with the growth of the individual. Penfield and Cone, in 1932, had somewhat the same idea in mind when they stated that the presence of a developmental spinal defect may prevent the normal progressive upward migration of the cord by incorporating the sacral nerve roots in a meningeal sac or by binding them down by abnormal fibrous bands.

Brickner, in 1918, called attention to the fact that it is not aways the defect *per se* that is responsible for the symptoms, but rather an associated set of conditions. He enumerated such a series of conditions which in his experience have accompanied spina bifida occulta and which have been responsible for the remote neuromuscular symptoms. They are as follows: (1) a distinct meningocele protruding through the bony cleft; (2) a closure of the cleft by a tough membrane adherent to the skin; (3) perforation of the membrane by a dense band attached to the subcutaneous tissues externally and compressing the cord structures internally; (4) fatty tissues lying within the canal concealed by this membrane; (5) a bulging of the dura mater; (6) an exostosis within the canal compressing the cord structures; (7) a myofibrolipoma extending through the cleft into the bony canal, compressing the cord and its roots; and (8) a degeneration of the cord tracts themselves. According to Findlay, writing in 1931, the fibrous tissue, which is occasionally responsible for pressure on the sacral roots, forms in an attempt to close the space between the gaping laminae to afford protection to the terminal portion of the cord. A superficial pad of fat resembling a lipoma often develops over the spinal defect as an added protection.

In addition to spina bifida, Burns and Helwig, in 1931, listed several other congenital abnormalities of the lumbosacral portion of the spinal column which may be associated with vesical dysfunction and relief from which may be obtained by appropriate treatment. Among these they included the following: (1) instability at the lumbosacral junction with dislocation or subluxation of the fifth lumbar vertebra, (2) increased lumbosacral angle or prespondylolisthesis and (3) spondylolisthesis. All three conditions may occasionally result in undue pressure on the cauda equina. To the foregoing list of deformities of the sacrum, Campbell added yet another, that of lateral displacement and angulation of the sacrum. In his experience it was the most commonly found anomaly other than spina bifida. Mertz and Smith, in 1930, summarized the influence of the structural defect on the vescial dysfunction

as follows: "The defect contributes to abnormal anatomical relations of the spinal cord and its membranes and may by adhesion or traction, by pressure due to a co-existing fibrous band, fatty tumor, a fibro-cartilaginous growth, or osteoma so disturb the physiological function of the subjacent nerves as to produce neurogenic vesical dysfunction."

NEUROPHYSIOLOGY

Though little question exists today that spina bifida and other abnormalities of the lumbosacral portion of the spinal column may interfere in some manner or another with the normal parasympathetic innervation of the bladder, there is, nevertheless, some difference of opinion as to the pathogenesis and character of the resulting neurogenic vesical dysfunction. According to Mertz, the mechanism of the vesical dysfunction is probably primarily purely irritative, the constant irritation affecting the vesical center of the cord and so altering its action that during sleep, when there is no psychic control, the bladder automatically empties itself. As the irritation continues or becomes more marked, there gradually develops a paralytic stage resulting in either retention or incontinence depending on the muscles affected.

Smith and Engel stated their impression that the disturbed parasympathetic innervation permits the influence of the sympathetic innervation to predominate, as a consequence of which partial or complete retention may occur. The presence of obstruction at the vesical neck, or absence of relaxation at this point, serves to stimulate the detrusor to compensatory hypertrophy and trabeculations develop. Complete retention, however, may eventually ensue, and later, as the degeneration of nerves progresses, the tone of the external sphincter is lost and active incontinence develops. Smith and Engel have pointed out that this last state of affairs is usually found associated with the most extensive types of defects in the lumbosacral portion of the cord. Burns and Helwig in discussing their cases emphasized the rôle of pressure or of injury to the cauda equina and entirely omitted mention of the possibility of a co-existing primary congenital deficiency of nerve tissue, or myelodysplasia. They differed, however, with Smith and Engel in contending that the sympathetic system plays little or no rôle in the pathogenesis of the vesical dysfunction and based their conclusions on the fact that their cases exhibited a relaxed vesical neck both cystoscopically and cystographically.

Recently, a new conception of the cause of the vesical dysfunction has arisen. Denny-Brown and Robertson,[5,6] and Munro, as a result of their clinical studies on patients suffering from complete destruction of either the sacral spinal segments or the cauda equina, described a type of dysfunction which they referred to as the autonomous type of neurogenic vesical dysfunction or the so-called autonomous cord bladder. In this particular type of vesical dysfunction the all-important parasympathetic innervation of the bladder has been partially or completely destroyed and whatever activity does occur in the detrusor muscle and internal sphincter must apparently occur as a result of impulses transmitted through "a reflex arc whose afferent and efferent arms are both parts of a neural plexus that lies wholly within the vesical wall." Apparently this intramural mechanism exercises some control over the vesical contractions despite the fact that the bladder is, except for its sympathetic innervation, completely divorced from the central nervous system. This type of bladder, because of its self-governing or autonomous character, is spoken of as the autonomous or the autonomic stage of the "cord bladder."

According to Munro, however, the autonomous bladder is a very inefficient bladder whose detrusor contractions may be only sufficient to cause reciprocal relaxation of the internal sphincter and may not reach a size sufficient to produce emptying other than by leakage. Residual urine is

usually present. As an end result these bladders are described as being hypertrophied and incapable of storing any significant amount of urine. These patients have a practically constant urinary dribble. Inhibitory impulses do not reach these bladders from the higher centers and both the voluntary and the reflex activity of the external sphincter are absent.

Whereas Denny-Brown and Robertson,[5,6] in 1933, and Munro, in 1936, approached this problem from its clinical aspect, Langworthy and his co-workers, in 1936, approached it from its experimental aspect. They produced autonomous cord bladders in the cat by sectioning the sacral roots and noted, after the period of shock had passed off, that rhythmic contraction waves which did not show any tendency toward summation developed in the bladder. Possibly as a consequence of their more or less constant autonomous activity and heightened tone, the bladders of these animals underwent marked hypertrophy. Owing to the feeble and unsustained nature of the vesical contractions residual urine was usually present and the perineums of these animals were always more or less wet and edematous. One of us (C. E. J.), working with the dog, recently has confirmed Langworthy's findings.

It is apparent from this discussion that the autonomous bladder is a relatively inefficient organ, the expulsive mechanism has been seriously impaired and forceful sustained contractions of the detrusor are no longer possible. Furthermore, a factor of altered resistance at the vesical neck is present. Two explanations are currently being offered to account for this latter condition. The first is that in the bladder of the normal animal, as a consequence of contraction of the detrusor, a reciprocal relaxation of the vesical neck occurs. In the autonomous bladder, since a sustained contraction of the detrusor is no longer possible, reciprocal relaxation of the internal sphincter cannot occur (achalasia). The second explanation is that a mechanical obstruction actually develops at the vesical neck as a consequence of the hypertrophy or of the hypertonicity of the detrusor muscle fibers at this point. There is much clinical evidence to support this point of view as many cases exhibit cellules and diverticula which would not ordinarily be expected to result from mere work hypertrophy (autonomous contractions) in the absence of obstruction of the vesical neck. Experimentally, the hypertrophy resulting from section of the sacral nerves is found to involve the entire bladder including the region of the internal sphincter.

While the defect in the innervation of the bladder in cases of anomalous defects of the lumbosacral portion of the spinal column usually involves both the motor and sensory divisions of the pelvic nerves and results in the autonomous type of neurogenic vesical dysfunction, it is possible for either division alone to be principally or exclusively involved, depending on the extent and nature of the spinal defect. If the posterior roots or sensory division is primarily involved an atonic type of neurogenic vesical dysfunction developes which resembles that seen in the tabetic bladder in which, as a result of impairment of vesical sensation, a gradual overdistention of the vesical musculature and gradual diminution or loss of explusive power occur. Involvement of the anterior roots of the sacral nerves, at least in the experimental animal, results in the autonomous form of neurogenic vesical dysfunction. Regardless, however, of the nature of the vesical dysfunction which ensues, the normal relation between the expulsive mechanism of the bladder and the so-called urethral resistance is altered and the function of the bladder is impaired.

SIGNS AND SYMPTOMS

The presence of a tumor at the lower end of the vertebral column may suggest the cause of the vesical dysfunction but more often than not, no such telltale sign is present. Often there is no external evidence whatsoever of a congenital defect in

the lumbosacral portion of the spinal column and one must rely entirely on the roentgenologic findings to reveal the presence of the defect. Occasionally, however, one or more of the following signs may be present and may provide a lead to the proper diagnosis: (1) a palpable defect in the lumbosacral portion of the spinal column, a depression in the sacrum, or merely a deep coccygeal fossa, (2) a fine white scar or a dimpling of the skin over the site of the defect, (3) a small tumor or a diffuse lipoma over the sacrum, (4) a pigmented area, nevus or area of telangiectasis over the lumbosacral portion of the spinal column, (5) hypertrichosis or a tuft of hair over the lower end of the vertebral column, (6) neurologic changes in the perineum and lower extremities, (7) deformities of the feet and lower extremities, as clawfoot, and finally, if graphic evidence is deemed essential, (8) compression of the dural cul-de-sac as shown by the roentgenogram following subdural injection of radiopaque oil.

The symptoms of neurogenic vesical dysfunction arising from congenital defects of the lumbosacral portion of the spinal column are those of enuresis, incontinence, either of the intermittent or of the constant variety, and retention of urine, either partial or complete. Though the symptoms may vary somewhat from case to case, incontinence in some form or another is usually present. Eleven of Mertz and Smith's thirteen cases presented incontinence of urine as their most outstanding symptoms, and nine of these cases presented some evidence of retention of urine as well. Nine of Smith and Engel's thirteen cases manifested frank incontinence unassociated with retention of urine. In their remaining four cases the patients were able to void small amounts of urine with great difficulty. Chute expressed the opinion that though the symptoms presented by ordinary cases of spina bifida might vary considerably they were usually associated with marked sensory and motor disturbances of the lower extremity, as clubfoot, ulcers of the foot and similar trophic disturbances. Campbell expressed more or less the same opinion, stating that the nerve lesion associated with spina bifida was often manifested by loss of control not only of the vesical and rectal sphincters but also of the muscles of the legs. It was also his impression that in a number of cases of co-existing spina bifida and vesical dysfunction without cutaneous sensory changes, the etiologic relationship might be exceedingly difficult to establish.

It should be emphasized that the onset of symptoms, particularly among older children and young adults, may be insidious. In some cases neither the patient himself nor the parents are aware of the development of urinary difficulty and it is only when recurring or resistant infection develops that further investigation reveals the presence of residual urine. At that time even casual inquiry will bring out the fact that the patient has been straining considerably to void and that urination is accomplished only in an intermittent fashion. However, in some cases the patient has been unaware that his stream was abnormally small and he is loath to believe that residual urine is present. Among infants the vesical dysfunction is evident by suprapubic pain and rigidity at the time of urination. In one of our cases the pain was severe enough to demand catheterization several times each night. Only in this manner could the child be relieved. Recurring chills and fever may be the cardinal signs and only when the persistent pyuria is investigated is the entity being discussed discovered.

We wish to stress the fact that symptoms in many instances are not present at birth but develop much later, occasionally as late as the second or third decade of life. Some of our patients had been accused of a neurosis or of hysteria as the basis of urinary retention. Pains in the suprapubic region, apparently due to vesical spasm associated with the dysfunction, are commonly noted, especially after infection has supervened.

TREATMENT

It is apparent from this discussion that several approaches to the problem of treatment are possible. Chute, in 1921, stated the problem as follows: "As the cause of the situation in these cases is probably due to a mechanical interference with the fibers of the cauda equina, it is useless to look for permanent relief by any means other than attacking the problem mechanically at the point where the interference has taken place." Brickner, at an earlier date had performed an exploratory operation in many of his cases, but finally reached the conclusion that "taken all together, the results of operation for spina bifida are not brilliant, and probably for the reason that the degenerative and neoplastic processes are scarcely remediable."

Campbell, in 1929, stated his impression that "treatment in these cases is most unsatisfactory and the attainment of a cure unlikely. In the majority of advanced cases the most one can do is to recognize the nature of the lesion, inform the patients of the true situation, and offer as much comfort as possible to the patient, bearing in mind that even in the presence of extreme renal destruction he may live for some years if an acute infection does not supervene." Campbell suggested that in the less severe cases, those manifested clinically by marked enuresis or partial incontinence, atropine may possibly be of benefit. More recently he has resected the vesical neck with a view toward eliminating the residual urine. Mertz and Smith, in 1930, mentioned several cases in which a successful result was obtained by release of traction or pressure on the structures of the cord. Aside from surgical exploration of the defect of spinal fusion, they added that the only other types of treatment available were those intended to overcome the existing infection such as "urinary antiseptics, the indwelling urethral catheter, pelvic lavage, permanent suprapubic cystostomy, plastic operations upon the ureter and pelvis, and ureteral transplantation." In the last type of treatment mentioned a competent anal sphincter must first be established before the operation is undertaken.

Burns and Helwig, in 1931, expressed the opinion that both orthopedic and urologic measures need to be instituted. Among the former they included the use of braces, stabilization of the lumbosacral portion of the spinal column with spinal fusion, and laminectomy with the relief of pressure on the cord. Among the latter they mentioned the use of urinary antiseptics and urethral dilatation. Smith and Engel, in 1932, suggested that patients suffering from incontinence be first given the benefit of an attempt at correction of the neurologic defect, after which correction of the relaxed sphincter by plastic means may be tried. This may be accomplished by means of Young's intravesical operation on the vesical neck or by transplanting the gracilis muscle. For those cases in which there is retention they have advocated the use of dilatation of the vesical neck, to be followed, if necessary, by exploratory laminectomy or presacral neurectomy or both.

McCarroll, in 1937, expressed the opinion that most cases of incontinence due to spina bifida fall into types in which "marked improvement and often perfect control can be expected from simple conservative measures alone," and that surgical intervention is not indicated in the majority of instances. By initiating a program of having his patients abstain from fluids after five in the afternoon and voluntarily void by straining every one to four hours during the day and as often as necessary during the night, he was able to eliminate their diurnal and nocturnal incontinence. If the patient's vesical capacity was unusually small it could often be increased by periodic vesical dilatations.

Recently, Nesbit and Gordon reported the successful use of transurethral resection of the vesical neck in two cases of autonomous vesical dysfunction. Both of their patients were men, aged eighteen and

thirty-five years, respectively. Examination had revealed a congenital defect of the lumbosacral portion of the spinal column and the symptoms of urinary difficulty had been present since birth.

One of us (G. J. T.) has had occasion to see a fairly large number of patients suffering from neurogenic vesical dysfunction arising as a result of myelodysplasia and spina bifida. Many of these patients were children who had been brought to the Mayo Clinic because of a chronic infection of the urinary tract, and who complained only of chills, fever and cloudy urine. Others had been brought because of poor control of the bladder and complained of enuresis, incontinence or retention. In many of these cases at the time of examination at the clinic dilatation of the upper part of the urinary tract had already developed. Formerly some of these patients underwent surgical exploration of their lumbosacral defect and an attempt usually was made at correcting the anomaly. Unfortunately, the majority of these patients had irremediable lesions and little was accomplished by the operation. Occasionally, to be sure, a very satisfactory result would ensue, but this was the exception rather than the rule.

Cystoscopic examination of the bladders of these patients, most of whom were children, usually revealed definite trabeculation of the detrusor and raised the question of the possible presence of a co-existing obstruction of the vesical neck. Frequently, and particularly when the bladder was distended, a rim of muscular tissue could be found extending around the circumference of the internal vesical orifice. When the bladder is distended, this tissue becomes quite spastic, contracting down to a small fraction of its former diameter in true iris diaphragm style. (We think that it is this entity which has for years been mistakenly called a type 3 congenital valve.) Trabeculations appear on the distended wall of the bladder at this stage of the examination and the urethra distal to the spastic portion of muscle surrounding the vesical neck also becomes distended, forming an asymmetric hourglass. The examination should be made with a panendoscope because the beak of instruments of other types will interfere with the contraction of the musculature of the vesical neck. On occasions the spastic tissue will be confined to one lip of the orifice.

In rare instances patients suffering from this disease are benefited by dilatation alone. Such patients are no doubt seen very early in the course of the development of vesical dysfunction and we believe that after a period of years mechanical obstruction requiring operation will develop.

Early in our experience in transurethral surgery it seemed logical that excision of tissue from the vesical neck in cases of vesical dysfunction due to spina bifida might be beneficial. It was conceivable that abnormal tissue in this location would cause obstruction to the egress of urine no matter what the etiologic factor; therefore, tissue was resected in the early cases we encountered, using a punch designed for the treatment of infants. Microscopic examination of the tissue removed in this manner revealed it to be hypertrophied smooth muscle. As a result of the removal of only a few pieces of tissue, the ability to void was considerably improved, the residual urine was lessened or entirely abolished, and the infection could be more easily controlled. As a consequence of this early and favorable experience with this method, it has been used more and more extensively, in fact, almost to the exclusion of any other method of treatment. Chemotherapy is employed in these cases before and after operation in an effort to control or eradicate the invariably present infection of the urinary tract.

As may be expected, the best results were obtained in the cases in which the symptoms were of comparatively recent onset, or those in which there was minimal damage to the urinary tract, and the poorest results were obtained in those cases in which there were prolonged symptoms and extensive damage to the upper part of

the urinary tract. In a few instances, however, an excellent result has occurred in advanced cases, possibly mainly as a result of lessening back pressure in the kidneys, thus permitting eradication of infection. As may also be expected from an understanding of the nature and pathogenesis of the dysfunction, permanent relief may not always be obtained and re-resection may occasionally be required. It is important, in our opinion, to resect tissue from the entire circumference of the vesical neck, making an effort to remove all muscular tissue which projects in any way into the lumen. Temporary relief was obtained in some of our early cases by fulguration and incision. These patients subsequently returned for further operation.

An inlying catheter should, of course, be used postoperatively to control bleeding and put the bladder at rest. The immediate result of operation is usually excellent and the patient is delighted with his ability to void. Control at this time is usually better than it may be subsequently.

Education of the patient in how and when to void is extremely important. He will be able to empty his bladder without much effort as a rule but if he does not follow a schedule, retention may develop again. A regimen somewhat like that which McCarroll has advocated is very desirable postoperatively.

CASE REPORTS

Case 1. The patient, a boy, aged two and a half years, was referred to the clinic for treatment of a chronic infection of the urinary tract characterized by urinary frequency, enuresis, chronic pyuria and recurring attacks of chills and fever. Examination elsewhere had revealed a postanal dimple and roentgenologic examination had revealed an underlying spina bifida. Residual urine had varied from 500 to 700 cc. An excretory urogram had revealed extensive dilatation of the ureters and kidneys, graded 3 to 4 (on the basis of 1 to 4, in which 1 designates the least and 4 the greatest dilatation). At the time of admission the patient had had an indwelling catheter in for three weeks.

General examination showed a fairly well developed male child. Urinalysis revealed moderate pyuria with Gram-negative bacilli. The concentration of urea in the blood was 52 mg. per 100 cc. An excretory urogram revealed marked dilatation of the upper part of the urinary tract while a retrograde cystogram revealed an irregular vesical outline partially obscured by hugely dilated ureters.

At cystoscopic examination an atonic bladder with numerous cellules was found. Both ureteral orifices were markedly dilated. Though there was not much obstructing tissue seen, a ridge-like protrusion of tissue was found on the right side of the internal sphincter and this was thought to be a factor in preventing relaxation of the sphincter. Valves were not present.

Transurethral partial sphincterectomy with the removal of several pieces of tissue was performed. The pathologist reported inflammatory tissue. Residual urine at dismissal was 20 to 30 cc.

This child had been quite well at the time of writing for seven years with no further recurrence of his former urinary symptoms. His development, as reported by his local physician, had been normal. No further word had been received regarding the state of the upper part of his urinary tract.

Case 11. The patient was a boy, aged ten years, whose past history had been uneventful. Pain in the back had developed one month prior to admission. A local physician had found pyuria. An excretory urogram at home suggested "polycystic kidneys."

General examination revealed an alert, active boy. The blood pressure was 142 mm. of mercury systolic and 104 diastolic. The bladder was palpable above the symphysis. Pyuria was graded 2 to 3. Micrococcus was present in the urine. The concentration of urea in the blood was 28 mg. per 100 cc. An intravenous urogram showed a functionless right kidney with no evidence of dye in the sixty-minute film. The left kidney presented pyelectasis and caliectasis graded 4 with fair function. The urogram suggested that very little cortical tissue remained. A diagnosis of spina bifida occulta of the fifth lumbar and first sacral vertebra was made.

Suprapubic cystostomy was performed, followed in one week by sphincterectomy. There was no evidence of congenital valve formation.

The vesical neck seemed to be slightly smaller than normal with several tags of granulation tissue projecting particularly from the anterior half. Several pieces of tissue were excised from the posterior vesical lip and the tags of granulation tissue were coagulated.

There was 15 cc. of residual urine at the time of dismissal. An excretory urogram one week after operation revealed some evidence of function on the right in the twenty and forty-five minute films, with pyelectasis and caliectasis graded 4.

When the patient returned three months later for recheck of the vesical neck it appeared normal. There was no tissue that could be removed or fulgurated. An intravenous urogram revealed bilateral hydronephrosis graded 4 as formerly.

Six years later the patient's mother reported that the patient had not had any further urinary trouble and recently had been chosen a member of the all conference high school football team.

Case III. The patient was a man, aged twenty-seven years. His past history was unremarkable. He had been well until four months before coming to the clinic when pain developed in the bladder, aggravated by urination. Gradually, difficulty developed in starting the stream with variable frequency (four to fifteen times) and nocturia (two to five times). There was occasional nocturnal incontinence. Urinalysis revealed pyuria and hematuria. The condition had been treated with sulfathiazole with no improvement. Cystoscopy had revealed a normal upper part of the urinary tract and "an anomalous condition of the posterior urethra." Though the patient had not had any chills, a low grade fever was present most of the time.

General examination showed a well developed man with "short disproportionate feet." Neurologic examination revealed saddle anesthesia of the perineum and relaxation of the rectal sphincter, graded 3. The blood pressure was 120 mm. of mercury systolic and 78 diastolic. The prostate was soft and enlarged, grade 1. The urine revealed only an occasional pus cell. The concentration of urea in the blood was 24 mg. per 100 cc. A roentgenogram of the lumbosacral portion of the spinal column revealed a congenital anomaly of the sacrum with bifurcation and sacralization of the last lumbar transverse process.

Cystoscopic examination showed 520 cc. of residual urine and acute cystitis with many points of hemorrhage. The expulsive force appeared normal. There was some questionable decrease of sensation. Moderate trabeculation and cellule formation were present. The internal vesical sphincter appeared to be dilated grade 2 and the verumontanum was hypertrophied.

Transurethral partial sphincterectomy was performed with the removal of 4 Gm. of tissue from the entire circumference. The pathologist reported adenomatous hyperplasia of the prostate. Sulfathiazole was administered. The residual urine was 90 cc. at the time of dismissal.

Since the operation the patient has had much less difficulty in voiding and has "better control."

Case IV. The patient, a man aged thirty-two years, was born with an "open sore" overlying the base of the spinal column which took many months to heal. Walking had always been complicated by the presence of bilateral pes cavus. Occasional rectal incontinence had been present, especially when his stools were loose. A local physician found "cyst of spine" and noted sensory and trophic changes in the lower extremities.

The patient came to the clinic because of increasing difficulty during the previous four years in voiding satisfactorily and because of several attacks of acute retention requiring catheterization. General examination showed a well developed and well nourished man who had bilateral pes cavus or callositas. An old scar was present over the lumbosacral portion of the spinal column. The blood pressure was 126 mm. of mercury systolic and 70 diastolic. Urinalysis revealed moderate pyuria. The concentration of urea in the blood was 20 mg. per 100 cc. Neurologic examination revealed a weakness of both legs with diminished sensation over both feet. The left patellar reflex was decreased. A roentgenogram (Fig. 1) of the lumbosacral portion of the spinal column revealed spina bifida of the fifth lumbar vertebra and entire sacrum with considerable deformity of the body of the fifth lumbar vertebra.

On cystoscopic examination the bladder was quite spastic and contained 90 cc. of residual urine. There was definite hypertrophy of the internal sphincter with moderate trabeculation and multiple cellules. Expulsive force and

sensation appeared grossly normal. The hypertrophy of the internal vesical sphincter simulated a medium bar with slight contracture of the vesical neck.

Transurethral resection of the vesical neck was performed with the removal of 6 Gm. of tissue from the entire circumference. The pathologist reported glandular hyperplasia and hyperplasia of muscle. An excellent postoperative result was immediately obtained and the patient has continued to void easily with no residual urine for the past four to five months.

Case v. The patient, a man aged fifty-two years, was born with bilateral club feet. The right foot improved with treatment but the left remained unchanged. At the age of twenty-one years he noticed progressive atrophy and weakness of the left lower extremity with the development of a limp requiring the use of a cane. At the age of seven years he had typhoid fever, during which acute urinary retention developed. He was never able to void after this and has had to catheterize himself three times a day ever since. There was occasional fecal incontinence with cathartics. One year prior to admission discomfort and a sensation of fullness in the perineum had developed. Three months prior to admission pain in the lower part of the abdomen and urethral discharge developed. Shortly prior to entering the clinic the patient had chills and fever and felt poorly.

General examination showed partial atrophy of the left lower extremity, bilateral club feet and an atonic rectal sphincter. The prostate gland was hard and probably malignant. Pyuria was graded 4 with gram-positive cocci. A culture of urine was sterile. A roentgenogram of the spine revealed a congenital deformity of the sacrum. An excretory urogram (Fig. 2) revealed bilateral pyelectasis, caliectasis and ureterectasis, graded 3 to 4, with apparent partial obstruction to the lower part of the ureters. The concentration of urea in the blood was 28 mg. per 100 cc.

Cystoscopic examination showed an ulcerating carcinoma of the prostate which was quite obstructive and which had caused considerable trabeculation of the bladder.

Transurethral prostatic resection was performed with the removal of 33 Gm. of tissue, which opened the bladder neck and prostatic urethra widely. The pathologist reported squamous cell epithelioma, grade 3 (Broders' method).

After operation the patient was relieved

Fig. 1. Plain roentgenogram of region of kidney, ureter and bladder. Note failure of fusion and deformity of the posterior laminae of the fifth lumbar vertebra and complete absence of fusion of the posterior laminae of all the sacral vertebrae.

of the need for catheterization. Later incontinence developed for which he wore a clamp. He was given roentgen therapy and stilbestrol with no improvement. Gradually progressive pyelonephritis and uremia developed and the patient died eight months after operation, apparently of gradual ureteral occlusion by the carcinoma of his prostate.

Case vi. The patient was a girl, aged two years. A small fatty tumor had been present over the left buttock at birth. She walked at nine months. She had been apparently well until pyelitis developed at one year. There had been no response to sulfanilamide. An excretory urogram had been reported to show bilateral hydro-ureter and hydronephrosis. At fifteen months the tumor on the buttocks had been excised, the pathologist's report being "a fat tumor with many nerve fibers." Following operation rectal incontinence had developed.

The patient's symptoms when she was brought to the clinic were diurnal and nocturnal urinary incontinence and frequency, pyuria, rectal incontinence and recurring periods of chills and fever. General examination revealed a well developed and well nourished child save for fullness or unusual prominence of the left buttock and partial atrophy of the left lower extremity. The rectal sphincter was relaxed. The patient was incontinent of urine with 4 to 6 fluidounces (120 to 180 cc.) of residual urine. The urine was loaded with pus and contained Escherichia coli. The concentration of urea in the blood was 28 mg. per 100 cc. The blood pressure was 110 mm. of mercury systolic and 70 diastolic. Neurologic examination revealed saddle anesthesia of the perineum. Roentgenologic examination of the lumbosacral portion of the spinal column revealed a congenital anomaly of the sacrum.

Cystoscopic examination showed marked trabeculation of the bladder with spasm of the vesical neck, particularly of the posterior vesical lip, when the bladder was distended. There was 7 to 8 fluid ounces (210 to 240 cc.) of residual urine.

Transurethral partial sphincterectomy was performed with the removal of "several pieces" of tissue, the pathologist's report of which was "inflammatory tissue." Regular small doses of sulfathiazole were administered.

Fig. 2. Fifty-five minute excretory urogram. Note failure of fusion of the posterior laminae of all of the sacral vertebrae and the malformation and malposition of the sacrum. Bilateral hydronephrosis.

The patient fared well postoperatively for approximately eight months, during which time her residual urine varied from 1 to 2 fluid ounces (30 to 60 cc.). Subsequently, however, her residual urine gradually increased to 4 to 8 fluid ounces (120 to 240 cc.) and she was brought back for re-examination. Cystoscopic examination revealed a recurrence of the former spasticity of the internal vesical orifice and eleven small pieces of tissue were removed from the entire circumference. The pathologist's report was inflammatory muscle and mucous membrane. Following this second operation her residual urine has remained at approximately 1 fluid ounce (30 cc.). The rectal incontinence has persisted, but the dribbling and overflow incontinence have been

much improved. No further chills or fever has ensued and the urine has been kept fairly clear by means of chemotherapy.

Case VII. The patient, a girl aged eleven years, had suffered since birth from pyelonephritis with recurring chills and fever and constant pyuria. A diagnosis of spina bifida had been made for which presacral neurectomy had been done with no apparent improvement. Neither ketogenic diet nor chemotherapy had been successful in controlling the infection.

At the time of admission to the clinic the patient complained of chills, fever, cloudy urine, occasional dysuria, straining to void and occasional pain in the lower left quadrant of the abdomen. General examination showed a mass over the left buttock and sacrum, suggestive of spina bifida. Pyuria was graded 2 to 4, and the urine contained Streptococcus faecalis and hemolytic streptococci. The concentration of urea in the blood was 44 and 48 mg. per 100 cc. The blood pressure was 105 mm. of mercury systolic and 60 diastolic. Residual urine was not determined. The neurologic diagnosis was spina bifida and myelodysplasia with neurogenic vesical dysfunction. Roentgenologic examination of the lumbosacral portion of the spinal column was reported as showing an apparent anomaly of development of the coccygeal segment. An excretory urogram revealed bilateral hydronephrosis and hydro-ureter, grade 4, with bilateral reduction of function.

On cystoscopic examination the expulsive force appeared excellent though the inner portion of the internal vesical sphincter seemed to elevate when the detrusor contracted. No apparent hypertrophy of the internal vesical sphincter was noted.

Transurethral partial sphincterectomy was performed with the removal of multiple bits of tissue, the pathologist's report of which was "inflammatory tissue." Sulfathiazole and mandelic acid were administered alternately. The residual urine ten days after operation was 15 cc.

Three months after operation the child voided much more easily and, though occasionally damping her clothes in the daytime, did not have any leakage at night. The residual urine was 60 cc. Cystoscopy revealed some persistent slight elevation of the posterior lip. Recently (eighteen months after operation) this patient was re-examined and the vesical neck was found to be quite flexible. The ureteral orifices were not as dilated as formerly and the urine was essentially normal. Since her residual urine had increased to 90 to 120 cc. the vesical neck was dilated with the Kollman dilator and following this the residual urine decreased. At the time of her dismissal she was able to control her urine perfectly unless she allowed her bladder to become overdistended.

Case VIII. The patient, a woman aged twenty-four years, had been born with spina bifida. She had walked at eighteen months though she always suffered from impediment in walking. Bilateral pes cavus, and many trophic ulcers of both feet developed. One toe had been amputated for failure to heal. Tendon operations had been performed on both feet to assist her in walking. Constipation had been very troublesome and required the regular use of laxatives.

The patient came to the clinic because of her inability to void, having been catheterizing herself three times daily for the past fifteen years. She also complained of lack of desire to void and of occasional incontinence with excitement. The urine was frequently cloudy. No chills or fever had been present.

At general examination a swelling of the soft tissue was present over the lower part of the spinal column, beneath which was a palpable defect of the fourth and fifth lumbar vertebrae. There was a cavus deformity of both feet and many calluses, ulcers and scars. The blood pressure was 114 mm. of mercury systolic and 70 diastolic. The rectal sphincter was tight. Neurologic examination revealed saddle anesthesia of the perineum, absent tendon reflexes and diminished sensation in both lower extremities. Urinalysis revealed mild pyuria and Escherichia coli bacilluria. Roentgenologic examination (Fig. 3) of the lumbosacral portion of the spinal column revealed that the fourth and fifth lumbar and all the sacral arches were open.

At cystoscopic examination the residual urine was 300 cc. There were marked trabeculation and diminished sensation and expulsive force. The internal vesical sphincter appeared fixed and hypertrophied with slight relaxation.

Transurethral partial sphincterectomy with the removal of several bits of inflammatory tissue was performed. There was little evidence of hypertrophy of the internal sphincter. The patient voided well following this procedure

but did not empty her bladder. Accordingly, a second resection was performed two weeks later and several more pieces of tissue were

Fig. 3. Plain roentgenogram of region of kidney, ureter and bladder. Note the failure of fusion of the posterior laminae of the fourth and fifth lumbar vertebrae and all the sacral vertebrae.

removed from the entire circumference of the vesical neck. The residual urine at dismissal was 45 cc.

The patient has been able to void satisfactorily for the past four years, using her abdominal and diaphragmatic muscles to assist in the act. It has not been necessary to re-employ the catheter. The urine has remained clear.

Case ix. The past history of the patient, a woman aged thirty-one years, was unremarkable. She came to the clinic complaining of chronic cystitis of twelve years' duration, characterized by severe urgency, frequency, dysuria and suprapubic pain.

General examination showed a well developed and well nourished woman, who had cystocele, grade 1, and rectocele, grade 1. The blood pressure was 145 mm. of mercury systolic and 75 diastolic. Urinalysis revealed pyuria, grade 4, with Aerobacter aerogenes bacilluria. The concentration of urea in the blood was 26 mg. per 100 cc. Neurologic examination gave objectively negative results except for slight anesthesia about the labia. The rectal tone was good. Roentgenologic examination (Fig. 4*a*) of the lumbosacral portion of the spinal column revealed a congenital anomaly of the sacrum and coccyx with lack of development of the lower right half of the sacrum. An excretory urogram revealed slight cicatricial changes in both kidneys. A retrograde cystogram (Fig. 4*b*) revealed an irregular vesical outline with sacculations and cellules. The residual urine on three occasions was 150, 150 and 200 cc.

Cystoscopic examination showed moderate hypertrophy and thickening of the internal vesical sphincter and marked trabeculation, grade 4. Sensation and expulsive force were normal.

Transurethral partial sphincterectomy was performed with the removal of twenty pieces of tissue from the entire vesical neck. The pathologist reported inflammatory tissue. Residual urine at dismissal was 10 cc.

Case x. The patient, a woman aged thirty-five years, had been well until three years before coming to the clinic when urinary retention developed with pyuria and recurring chills and fever. There was 1,000 to 1,200 cc. of residual urine on several occasions.

Neurologic examination gave essentially negative results. The rectal tone was normal. The blood pressure was 110 mm. of mercury systolic and 76 diastolic. Urinalysis revealed pyuria grade 2 to 3, with Escherichia coli bacilluria. The concentration of urea in the blood was 16 mg. per 100 cc. A cystometrogram revealed a shift to the right (with diminished sensation and first desire to void at 520 cc.). A roentgenogram of the lumbosacral portion of the spinal column revealed spina bifida occulta of the first sacral vertebra.

Cystoscopic examination showed 300 cc. of residual urine. The bladder appeared to be atonic with no evidence of either obstruction of the vesical neck or trabeculation.

Exploratory laminectomy with removal of fibrous bands compressing the cauda equina was performed. As this did not produce any relief of symptoms, resection of the presacral nerve was performed six weeks later, again with no relief of symptoms. Transurethral sphincter-

otomy was performed five months after resection of the presacral nerve, the Collings knife being used to incise the sphincter on each side of the floor of the urethra.

reported. Five patients were males whose ages ranged from two to fifty-two years and five were females whose ages ranged from two to thirty-five years.

FIG. 4. *a*, plain roentgenogram of region of kidney, ureter and bladder. Note the marked malformation and malposition of the sacrum, with complete failure of fusion of the second, third, fourth and fifth sacral vertebrae; *b*, cystogram exhibiting retention type of bladder with cellules and diverticula.

After the third operation the patient was well for one year when symptoms of cystitis returned. There was 20 to 30 cc. of residual urine. Local treatment in the form of vesical lavage was successful and the patient was well for five years, when her former symptoms of retention and infection recurred. Cystoscopic examination revealed a contracture of the vesical neck. Dilatations of the vesical neck again afforded relief of the patient's symptoms.

SUMMARY

Ten cases of neurogenic vesical dysfunction due to congenital anomalies of the lumbosacral portion of the spinal column and spinal cord in which transurethral resection of the vesical neck had been performed with relief of symptoms have been

The presenting symptoms of the ten cases of neurogenic vesical dysfunction were quite variable. Four patients complained of chronic urinary retention necessitating periodic catheterization while two complained of recurring acute urinary retention. Two complained of complete loss of control of urination with an active type of incontinence. Three complained of vesical irritability with frequency and dysuria while four complained of recurring chills and fever and chronic pyuria.

An apparent obstruction was seen cystoscopically in eight of the ten cases while in the remaining two cases no obstruction was evident. In both of these cases, however, the patients were relieved of their symp-

toms of obstruction by resection of the vesical neck. In seven of the cases either trabeculation or cellule formation or both were evident while in the remaining three cases the presence or absence of trabeculation and cellules was not recorded.

Partial or complete sphincterectomy was performed in five cases while resection of the vesical neck and obstructing prostatic tissue (4, 6 and 33 Gm.) was performed in three cases. Sphincterotomy or mere incision of the internal vesical sphincter was performed in two of the early cases. There were no operative deaths though one patient died eight months after operation from pyelonephritis and uremia.

Five of the patients were greatly improved, four were improved, and one was temporarily improved. The following conclusions have been drawn:

1. Transurethral resection of the vesical neck lessens the urethral resistance and reduces or abolishes the residual urine.

2. Elimination of the residual urine and control or eradication of the infection of the urinary tract in these cases serve to preserve the anatomic integrity and functional efficiency of the upper part of the urinary tract.

3. A rigid postoperative regimen of routine voiding by the clock and of abstaining from fluids in the evening should be instituted.

4. In the majority of cases great improvement in urinary function has resulted from the operation; in some cases normal vesical function has been restored.

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PLASTIC SURGERY IN THE TREATMENT OF WAR CASUALTIES*

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THE term, plastic surgery, is somewhat misleading but has become so well established that change is difficult. Since the first world war the term, "maxillofacial surgery," has been used in the medical services of the army and navy. This would suggest that plastic surgery is limited to the jaws and face. Reconstructive surgery is a better term. Staige Davis, whom Sir Harold Gillies recently described as the "grandfather of plastic surgery in America," defines plastic surgery as that branch of general surgery which has to do with the reconstruction of injured, lost or deformed parts all over the body, and is concerned primarily with restoration of function and secondarily with improvement of appearance. At the close of the previous war plastic surgery was being done for the most part by men with dental or ear, nose and throat training. Today it is generally recognized as a special branch of general surgery requiring thorough training in general surgery and a working knowledge of several other specialties. The American Board of Plastic Surgery was set up in 1939. A committee of this Board and the two plastic surgery societies, of which Dr. Gordon New of the Mayo Clinic is chairman, has completed a survey of existing facilities for the study of this subject. This survey shows that these facilities are inadequate for peace times. Now that all types of residencies have been sharply limited, training in plastic surgery will be almost nonexistent. This is a serious situation in view of the fact that only about 125 surgeons have been certified by the American Board of Plastic Surgery.

To quote from the Manual of Plastic and Maxillofacial Surgery prepared by the National Research Council and the Medical Department of the U. S. Army,[1] "The Casualty from the field of battle has a right to expect and demand the optimal result which can accrue from a highly cooperative professional service and a skill which results from the utilization of all that is best in the general and special experience related to his particular problem. His future mental comfort and success in the competition of living will be materially influenced by his facial function and appearance." The preliminary treatment of the casualty determines to a large extent the outcome of later reconstruction. Prompt local hemostasis, pressure bandages, use of small hemostats and fine ligatures, conservation of bone fragments which are attached and soft tissue which is viable—all these points should be kept in mind as the casualty passes from the Battalion Aid Station through the Clearing Station and Evacuation Hospital.

The medical officer is often faced with medical or surgical situations with which he must deal without consultation or assistance. He should be acquainted with the principles of reconstructive surgery. He should know how to close wounds of the face and when to leave them open. A skin graft is often the best dressing for a wound. He should be able to cut and apply the simpler types of skin grafts and care for them. The early local treatment of a severe burn will determine to a large extent the time required for healing and the degree of permanent disability.

After the casualty has been removed from the combat zone and has recovered from shock a complete examination can be made and treatment outlined. Fractures of

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the facial bones with displacement can frequently be determined before *x*-ray examination if swelling and tenderness are not too great. Bilateral palpation of the face bones from above downward is helpful. The order of frequency of fracture of the facial bones is: mandible, nose, zygoma, maxilla and multiple fractures. Failure to reduce a fresh fracture requires extensive surgical measures later, but it can be reduced within the first two or possibly three weeks. These fractures should not be manipulated and the nose should not be packed in the presence of cerebral fluid drainage. Delay reduction for at least ten days after drainage ceases.

The nose is the most prominent facial feature. Marked abnormalities create a definite economic and psychic hazard. Reduce the fracture as soon as possible. *X*-ray is not very helpful in most cases. If uncertain as to diagnosis, wait until the swelling has subsided. Examine both the inside and outside of the nose for displacement and movement. The mucosa is anesthetized with cocaine solution 10 per cent and epinephrine 1-2000 on cotton applicators placed upward, backward and laterally and also along the floor of the nose. The external soft parts are injected with 0.5 per cent solution of procaine and epinephrine (10 gtt. to the ox.) along the bases of the nasal processes. Elevate and straighten the nasal septum and return the cartilage to its groove in the vomer. Loosen fragments of the bony arch, elevate and rotate them into position. Any thin strong instrument covered with thin rubber tubing can be used inside the nose. Light vaselined gauze packing and an external splint may be applied. Remove the packing in twenty-four hours.

Fractures of the zygoma usually show depression of the arch of the cheek bone, flatness above and swelling below. Motion of the jaw may be limited. Unilateral nasal hemorrhage, infra-orbital nerve anesthesia and diplopia may be present. Most of these fractures can be reduced by one of the following methods: *through the antrum* (by an intranasal opening or through the canine fossa); *through the mouth* by an incision above the last upper tooth, inserting an antrum trocar under the zygoma for manipulation and elevation; *by the temporal route* through an incision in the hairline above and in front of the ear, passing a periosteal elevator through the temporal fascia, downward and forward beneath the zygoma. The skull is used as a fulcrum to lever the fragments into place.

Fractures of the maxilla and especially those of the *mandible* usually require some type of permanent fixation after soft tissue wounds have been treated. All completely detached pieces of bone or teeth should be removed but any fragments of bone still attached to the soft tissues should be preserved. It is better to leave a doubtful bone fragment and remove it later if necessary. The co-operation of the dental surgeon will be required for inter- or intramaxillary wiring if needed. In some cases skeletal reduction and fixation by internal wiring or modification of the Roger-Anderson method may be used. *X*-ray examination should be made for concealed foreign bodies.

Later reconstruction of bony defects of the face involves some type of camouflage procedure such as grafts of cartilage, bone, dermo-fat, fascia. Peer[2] has recently suggested what he terms, "diced cartilage," for filling these bony defects of the face. The patient's own cartilage is cut into very small cubes and introduced into the defect through an incision below it. The excess is squeezed out and the cartilage patted into the proper contour. Peer states that this type of cartilage graft remains viable, does not change shape and in time becomes quite vascular.

Soft tissue wounds of the face may be treated somewhat differently than wounds of the rest of the body. Because of the better blood supply the tendency to infection is less and the healing more rapid. If the wound is seen within ten or twelve hours and is not grossly dirty, greatly contused or ragged, it may be sutured without

preliminary treatment except irrigation with saline. If first seen after twelve hours, it should be left open, dusted with a sulfonamide powder and saline or bland ointment dressing applied. If the wound is fresh but dirty and can be cleaned with soap and water followed by saline, it may be dusted with sulfonamide powder and closed. Débridement should be less radical in the face than elsewhere. Doubtful flaps even with a small pedicle should be preserved if possible and sutured in place. Attached bone fragments should be preserved and replaced. If hemostasis is doubtful a small rubber strip should be placed between the sutures and removed in twenty-four hours. Small hemostats and fine ligatures must be used. The use of deep sutures is desirable but this will depend upon the judgment and experience of the surgeon. If in doubt they should be omitted. Fine needles and fine suture material are essential and the sutures should not be left in more than three days. At the first sign of infection sutures should be removed and a wet dressing applied. Face wounds like all others should be immobilized as much as possible; talking should be prohibited and feedings done by syringe or tube in the stomach.

The early local treatment of burns under combat conditions will probably be more or less standardized by order. Some type of crust treatment may be used if time permits. The best crust methods are tannic acid, tannic acid and silver nitrate, triple dye, and sulfadiazine in triethanolamine. The crust treatment reduces pain and fluid loss and simplifies the early care of the burned patient. The sulfadiazine-triethanolamine and triple dye crusts form more slowly than the tannic crusts but they are more pliable and infection is less frequent. Crusts should never be used on the face, hands or genitalia. No crust should be left on a third degree burn longer than three weeks. It should then be removed and the defect grafted as soon as all necrotic tissue has disappeared and the granulations are pink, firm and relatively level. The dermatome may be used to cut large grafts which are sutured in place and fixed with elastic pressure (sponges or cotton waste). The safest graft to use, if one is not experienced, is the small deep graft of Davis. These grafts are small pieces of skin, full thickness in the center and thin at the edges. They are picked up on a needle held in a clamp and cut as described by Davis[3] with a knife or razor blade held in a clamp. They may be placed as close together as desired. These grafts should never be applied to exposed parts such as the hands or face. Whichever type of graft is used on a granulating surface, the first dressing should be done on the third day and the elastic pressure continued for a week to ten days. Other methods of treatment are the envelope method favored by the British,[4] the pressure method[5] and the saline bath method.[6] The envelope treatment employs an oiled silk sleeve with an inlet and outlet which fits snugly to an extremity. Electrolytic sodium hypochorite flows slowly through the sleeve. Saline or a sulfa solution may be used instead of the sodium hypochlorite. The pressure method uses sulfonamide powder covered with vaseline gauze, cotton waste and a cast or elastic pressure bandage. Burns of the face may be sprayed with a fine sulfonamide powder and covered with one layer of vaselined gauze and a saline pack. The saline bath method requires more nursing care than is available under wartime conditions.

The *treatment of the contracted scars*, which so often follow severe burns, presents a major plastic problem. The degree of contracture is directly proportional to the healing time. The longer the time required for healing, the thicker the scar, and the thicker the scar the greater the contracture will be. Thick scar webs on the neck and face and across joints of the extremities are not only unsightly but interfere greatly with function. Thick burn scars may continue to contract for weeks or months after surface healing is complete. This tendency varies greatly in different individuals even to the point of true keloid formation.

Plastic reconstruction should be delayed until the scars have become relatively soft and most of the redness has faded. Four to ten months may be required to reach this stage. Flaps of scar tissue can then be shifted within reasonable limits so that tension is removed and function restored, frequently without the necessity of grafting or moving flaps from a distance. One of the best ways of doing this is by transposing the points of a z-shaped incision.[7] Whatever method of shifting flaps is used the new suture line should run at angles to the former scar band. Contractures relieved by shifting flaps do not recur if the blood supply of the flaps has been accurately appraised and they remain completely viable. When grafts are used instead of flaps some degree of contraction of the grafts follows and relief of the contracture is not complete. However, if complete relaxation cannot be obtained by shifting flaps, the remaining defect must be covered with a graft.

What has just been said concerning the shifting of flaps instead of applying grafts emphasizes one of the first principles of plastic surgery. This principle is that all available adjacent tissue should be utilized in the correction of a defect before bringing in tissue from a distance. With the advent of new methods and new instruments there is a tendency to forget that established surgical principles remain unchanged. The Dermatome, invented by Earl Padgett, has made the cutting of large skin grafts of predetermined thickness a relatively simple matter. This instrument, properly used, represents a real technical advance in skin grafting and if the principle mentioned above is followed, it will not be misused.

The scope of this paper does not permit detailed discussion of types of grafts and flaps which will be needed in the reconstruction of the defects produced by modern instruments of warfare. Skin grafts vary as to thickness and size. The full thickness graft is cut according to a pattern of the defect to be covered. It is carefully dissected so that no fat remains on its undersurface, sutured accurately into its new site and dressed under elastic pressure for over two weeks. This graft requires a firm, sterile bed. It can be used only on a fresh, surgical wound and in an area which can be completely immobilized. Its "take" is less certain than a part thickness graft, cut with knife or Dermatome, but if it takes completely gives a good functional and cosmetic result. Part thickness or split grafts take more readily, and if cut through the deeper layers of the skin yield almost as good a result. They have the added advantage of leaving enough skin elements for regeneration of the donor site. The usefulness of the small deep graft of Davis in grafting large, deep burns when the condition of the patient is poor has been mentioned.

Flaps differ from grafts in that they include both skin and fat and depend for survival on an intact blood supply. One end of a flap must remain attached and carry the blood supply while the other end is growing into its new site. After two to three weeks the second end has acquired a new blood supply; then the first end may be detached and the rest of the flap fitted into its new location. Flaps may be brought from a distant part of the body by rolling them into a tube and grafting one end temporarily into a movable part, usually the hand or wrist. Flaps are useful in correcting defects of contour and for covering exposed tendons and other deep structures but they require multiple operations and long hospitalization while grafts usually need but one operation. Flaps retain their original color fairly well but grafts are prone to show increased pigmentation at times. Flaps contract scarcely any after they are fitted to their new site but grafts may show over 50 per cent contraction if cut through the outer quarter of the skin. All grafts contract somewhat but the thicker the graft the less the contracture. It should be remembered that a graft is always a "patch," and seldom matches the surrounding skin perfectly. A rotated or shifted flap of normal adjacent tissue is

always more satisfactory if available. Rather extensive scars may be removed by repeated, partial excisions. At times it is desirable to apply a temporary graft then later excise the graft in stages, with long intervals between them. It should be emphasized that grafts are a rather poor substitute for the original skin but they should be used without hesitation when indicated.

An opportunity is sometimes missed because the surgeon does not think of the possibility of immediate grafting of a traumatic wound with loss of tissue. This may be important in getting a war casualty back into service quickly. If the wound is seen within six hours of the injury and is grossly clean or can be débrided satisfactorily, and the defect cannot be closed in a reasonable manner, immediate grafting should be considered. A graft of any desired thickness or length and up to one and three quarters of an inch in width can be cut with an ordinary safety razor blade held in a clamp. The graft is tacked at several points with interrupted sutures, trimmed to fit, and a running suture of "c" silk carried around the edge. Several small holes should be made in the graft for drainage of serum. The graft is then covered with one layer of vaselined gauze and one thickness of saline gauze sponge. Over this is placed a rubber sponge, synthetic sponge, sea sponge or cotton waste and firmly bandaged. The first dressing is done on the fifth day or earlier if an odor or other sign of infection is observed. Elastic pressure is continued for ten days to three weeks depending upon the thickness and condition of the graft. When the back of a hand is denuded, exposing tendons, the hand may be placed under an abdominal flap through two parallel incisions. When the skin and fat pad of a finger tip is lost the defect may be attached to a flap raised on the proximal part of the palm or to a similar flap on the abdomen. The subsequent care of these flaps follows the principles of flaps elsewhere.

SUMMARY

1. The war casualty should receive the benefit of modern methods of reconstruction. The preliminary treatment of the casualty may determine to a large extent the outcome of later reconstruction.

2. Facilities for postgraduate training in plastic surgery should be augmented to meet the demand for surgeons properly trained in this specialty.

3. Conservation of tissue is important in care of wounds and compound fractures of the face.

4. Early skin grafting is essential in the treatment of large deep burns. When possible a method of early local treatment should be used which will facilitate early grafting.

5. Contracted scars should be relaxed by shifting flaps and skin grafts used only as an alternative.

6. Immediate grafting of certain wounds should be considered as a means of preventing deformity and shortening the period of disability.

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HYDROCALYX*

ITS RELIEF BY RETROGRADE DILATATION

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THE treatment of hydrocalyx has always been either by nephrostomy with dilatation of the isthmic stricture or by calycealectomy. In some cases nephrectomy is performed. In any event an open operation is done. The case presented here is one in which a catheter penetrated an infundibular stricture, entered the hydrocalyx and allowed free drainage thereafter with complete relief from symptoms to the patient. This was inadvertently done during the course of a routine retrograde pyelography wherein catheters were passed into the renal pelves. Such a case has not been found in urological literature.

Dilatation of a single renal calyx not attended by concommitant dilatation of other calyces in the same kidney is due to obstruction or stricture of the isthmus between the calyx and the pelvis. The isthmic portion is usually designated as the infundibulum of the calyx and such a dilated calyx is referred to as a hydrocalyx or hydrocalycosis of the kidney. This is to be distinguished from the state of dilated calyces occurring in pyelonephritis which is referred to as "clubbing" of the calyces and is not due to obstruction but to adynamic factors in the calyces (Braasch and Doss). Infundibular constriction may be due to localized infection with consequent stricture of a portion of the pelvis causing calyceal stasis and the formation of calculi in a great many cases.

CASE REPORT

M. B., a twenty-nine year old male, was first seen in April, 1941, complaining of persistent dull ache in the right loin with occasional attacks of sharp pain. This symptom was persistent during the past year and the paroxysms of sharp pain had increased in frequency in the past two weeks. Physical examination revealed a well nourished but slightly built male of twenty-nine years having definite tenderness on firm palpation over the righ renal area. He had always enjoyed good health in the past. There were no other relevant findings; his urine was clear and he was sent in with a provisional diagnosis of right renal stone. A No. 24 Brown-Buerger cystoscope was passed into the bladder with ease. The bladder mucosa was normal in all respects and there were no foreign bodies or signs of inflammation. A No. 6F opaque catheter was inserted into each ureteral orifice and passed up into each pelvis without difficulty. Specimens were collected for urea, microscopic examination and culture; phenolsulfonphthalein appearance time was three minutes from each side. Specimens were collected for percentage determination. A flat plate with the catheters in place revealed no evidence of opaque shadows. The kidneys were of normal size and the psoas muscle outlines were fairly clear. Six cc. of 20 per cent diodrast was then injected into the left pelvis before the patient felt some pain and not until 20 cc. of diodrast was passed into the right pelvis did the patient experience pain on that side. A pyelogram was taken and this showed a large dilatation of the superior calyx of the right kidney with a definite stricture of the infundibulum of that calyx. The rest of the right kidney as well as all of the left kidney showed no abnormality. Urea and phenolsulfonphthalein excretion determinations were normal. Cultures showed no growths and microscopic examination was essentia ly negative. The right catheter had penetrated the stricture and entered the calyx thereby offering free drainage. (Fig. 1.)

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The patient was told to return a week later. At that time he stated that all the pain in his right loin was gone and that he was free of all symptoms. He was cystoscoped again and a No. 7F bougie was passed into the right pelvis. Thereafter he was told to return every three weeks and on each occasion the isthmus of the calyx was dilated. The patient consented to these treatments under some protest, stating that he felt perfectly well, had no symptoms whatever and could see no reason why he should be required to return for further treatments.

Fig. 1. Routine pyelogram taken when patient was first seen. Catheter is shown penetrating infundibular stricture of superior calyx of right kidney and entering hydrocalyx.

Fig. 2. Right pyelogram taken seven months later. Catheter is used to dilate isthmic stricture. Hydrocalyx slightly smaller than when first seen.

A right pyelogram taken seven months after he was first seen showed a moderate diminution in size of the dilated calyx, a lengthened infundibulum of that side with the catheter occupying the isthmus and entering the calyx. (Fig. 2.) The patient was still symptom free and dilatation of the isthmus with Nos. F7, 8 and 9 catheters every three weeks was continued until January, 1942. He was given a rest period of nine months during which time he had experienced none of his previous pain and enjoyed good health. On October 26, 1942, which was nine months after he was first seen, pye'ograms of the right side were again made. (Figs. 3 and 4.) This time several *x*-ray exposures were made before it was ascertained that the catheter had entered the hydrocalyx. It was necessary to change his position slightly in order to try to get the catheter to enter the superior calyx. Figure 3 shows the unusual course the catheter followed before entering the infundibulum. In Figure 4 the dilated calyx is well outlined and, by comparing with Figure 2, it appears that the calyx is slightly smaller in size and much smaller than in Figure 1 when the patient was first seen. Cultures of the right kidney showed no growth and function according to phenolsulfonphthalein determination was normal as was the urea elimination. No pus cells were seen in the catheterized specimen. There were no other abnormalities. This patient has never shown any evidence of infection of the upper urinary tract at any time.

There were times during the course of these dilatations when the catheter would not enter

the superior calyx. In that case it was necessary to manipulate the catheter by twisting or by changing the position of the patient by having him rotate to right or left before we could see the catheter pointing in the direction of the superior calyx. A stylet was never used to splint the catheter as the danger of such a maneuver is apparent. Not infrequently during the course of routine retrograde pyelography we see the catheter enter the superior calyx.

Fig. 3. Plain plate taken eighteen months after admission showing unusual course catheter followed before it entered superior calyx.

Fig. 4. Pyelogram of Figure 3 showing catheter in hydrocalyx which is considerably smaller than when first seen in Figure 1.

Although this is a study of one case it points out three definite facts: (1) There is definite pain in a distended calyx in which there is no stone. (2) In some instances it is possible to relieve the patient by retrograde dilatation without the necessity of open operation. (3) An infundibular stricture of the superior calyx is the most accessible one for this type of treatment.

At the time of the preparation of this paper, twenty-two months after the patient was first seen, he is still free of all symptoms.

In reviewing the literature the age incidence of hydrocalyx occurs in the third decade of life with almost constant regularity. Braasch reported a case of a twenty-seven year old male with infundibular stricture and dilated calyx without stone. The patient was relieved of all symptoms after free drainage of the hydrocalyx by a nephrostomy and dilatation of the stricture were done. Braasch believed that a calycealectomy was not necessary.

Prather reported three cases of calyceal diverticula all in adults in their third decade of life. In each case a nephrostomy was done. Only one of these cases did not show the presence of a stone. Prather's treatment of these patients consisted of nephrostomy, dilatation of the infundibular stricture with a Kelly clamp and an attempt at approximation of the calyceal walls with nephrostomy sutures. Pyelograms taken a year later in one of his cases

showed that the walls did not remain approximated and that the diverticulum had diminished in size and was not retentive. The patient was symptom-free.

stricture of the infundibulum in a twenty-one year old female whose urine was clear at all times. She was relieved of all symptoms by open operation. Braasch, too,

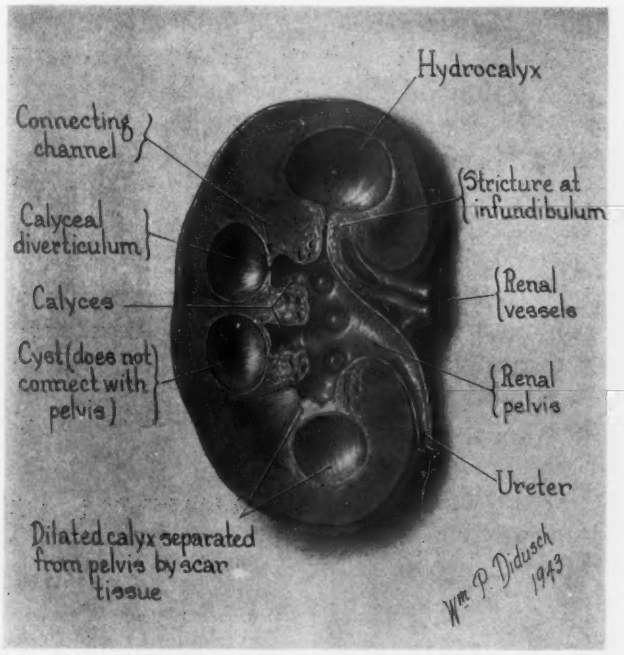

Fig. 5. Composite illustration showing the differences between hydrocalyx, calyceal diverticulum, cyst of the kidney and obliteration of calyx following pylonephritis.

Hyams and Kenyon reported four cases of dilated calyces of a different nature. In their cases the patients had all recently recovered from an acute attack of pyelonephritis which was followed by stricture formation of the infundibula. This condition was described as "localized obliterating pyelonephritis."

The distinction between hydrocalyx, calyceal diverticulum, renal cyst and localized obliterating pyelonephritis may be summed up briefly in the following four paragraphs.

Hydrocalyx. Dilatation of a single calyx due to obstruction may be defined as hydrocalyx (Watkins). He also states that when there is no apparent obstruction the cause may be due to achalasia at the neck of the calyx or at its junction with the renal pelvis (ring muscle of Disse). G. G. Smith stresses the rarity of dilatation of a single calyx which is not due to ulceration or stone formation. He reports a marked stresses the rarity of infundibular stricture and doubts that the constriction is ever congenital. He calls attention to the fact that retention and blockage due to constriction may only be temporary and hence may be demonstrated only at the time of pain. Hyams states that the initial reduction in caliber of the infundibulum seen in hydrocalyx seems to remain static if there is no infection. He recalls one of his cases in which there had been no diminution in size of the lumen during a six-year period of observation.

Calyceal Diverticulum. This is not to be confused with hydrocalyx. A calyceal diverticulum is a dilated cavity distal to and not part of the calyx but is connected to the calyx by a small channel. This was very well brought out by Prather in his recent paper. He reported three such cases, all in the third decade of life.

Renal Cyst. Cysts situated adjacent to the renal pelvis will sometimes rupture into

the pelvis with secondary infection and cause acute symptoms. Here it may be difficult to differentiate such cysts from a dilated calyx or calinephrosis caused by obstruction or constriction of the infundibulum (Braasch). Ridlon showed a cortical cyst of the kidney communicating with a calyx through a pin-point opening. Its pyelographic appearance was very much like that of a calyceal diverticulum. Repeated ineffectual emptying of an enlarged calyx causes increasing dilatation and destruction of the overlying renal tissue. In the final stage the communication with the pelvis becomes obliterated and what was once a hydrocalyx has now become a true cyst (Kenneth Watkins).

Localized Obliterating Pyelonephritis. During the course of pyelonephritis the infundibular portions of the calyces are sometimes the seat of a marked inflammatory process. This process may go on to terminate in stricture formation with either complete destruction and disappearance of the involved calyx or to isolation of the calyx from the pelvis by an impenetrable stricture. This process has been called "localized obliterating pyelonephritis" by Hyams and Kenyon. The clinical differentiation of this process from cysts located near the renal pelvis is made by the previous history, urinary findings and the course of the disease.

CONCLUSIONS

A case of uninfected hydrocalyx without stone which was relieved by retrograde dilatation is presented. Three salient points are brought out: (1) Hydrocalyx of the superior calyx can be relieved in some instances by retrograde dilatation with consequent free drainage. (2) There may be definite pain in a distended calyx in which there is no stone. (3) Open operation is not always necessary.

A review of the literature and differential diagnosis is made of hydrocalyx, calyceal diverticulum, renal cyst communicating with the pelvis, and localized obliterating pyelonephritis.

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MANAGEMENT OF ACUTE SUPPURATIVE APPENDICITIS IN THE SMALL RURAL HOSPITAL*

A REPORT OF ONE HUNDRED CONSECUTIVE CASES

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DEATH should have a sobering effect on the medical attendant as well as on the family of the deceased. Medical or surgical deaths should be looked upon as unsolved problems. Two deaths from acute suppurative appendicitis on my service, occurring within a period of four months, provided the stimulus for the study which culminated in the writing of this paper. These deaths occurred in 1939 and in the following two years, included in this study, thirty-five cases have been treated without a death.

Heyd[1] has said, "Within very definite imits, there should be no deaths from appendicitis." He goes on to say, "The presence of pus, gangrene or general peritonitis at the time a patient is operated upon for appendicitis, is in a large measure proof that the case has been neglected or delayed."

Appendicitis, which causes over 16,000 deaths annually in the United States, presents a problem worthy of the united efforts of the medical profession and intelligent laymen, but for some reason this problem seems to lack the appeal that goes with the fight against cancer, tuberculosis, syphilis, heart disease, etc. Little difficulty is encountered in establishing foundations and endowing fellowships for the study and control of these diseases, yet year after year an inexcusable mortality is chalked up against appendicitis, when a little flag waving and drum beating in that direction might save thousands of lives. It is true that the mortality from these other diseases is higher than that from appendicitis, but is it not also true that the deaths from these are more likely to occur among older and do I dare add less valuable citizens? In the series of cases to be discussed in this paper 70 per cent of the attacks were in patients under thirty years of age and 80 per cent were in patients under forty years of age. More than half of the attacks were in the second and third decades of life when the average individual is just entering the most promising part of his career. The attack on appendicitis, from the public health standpoint, has lacked the attention that it deserves; yet the efforts that have been invested in it have paid large dividends in human lives. A glance at the experience in Philadelphia, where several organizations, including the County Medical Society and the Association of Retail Druggists co-operated in placing posters in drug stores urging patrons to see a physician and not take a laxative when afflicted with abdominal pain, shows what can be accomplished. The mortality from appendicitis in Philadelphia has been reduced almost 60 per cent since 1928, when this educational program was instituted. The same program, if made countrywide might save 10,000 lives annually. We offer no objection to the warning, "Don't spit on the sidewalk," when it is plastered up in the most conspicuous places. I do not believe it would be any more abhorrent to see displayed in public places the admonition, "Don't take a physick when you have a pain in the belly." It would at least provoke discussion.

Sufficient thought has not been given to the problems peculiar to medical and surgical practice in rural communities. A conference on rural medical practice was held at the Mary Imogene Bassett Hos-

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pital at Cooperstown, New York, several years ago, where some of the problems of the rural practioner were discussed. Simons[2] has published a study of pneumonia in a town of 435 inhabitants, making a comparison between the results of treatment in rural and city practice. Other studies on the care of certain diseases, away from the thickly populated districts, have been published, but a preponderance of medical literature, even that concerning rural health problems emanates from large urban centers and the papers are usually written by observers who have little if any contact with rural medicine. The opportunity for observation of patients in greater numbers and the stimulating effect of contacts with the teaching centers make this inevitable. However, there is a real challenge to the rural physician or surgeon to study the problems of disease as they affect his particular domain of practice.

The pathological processes which go on in the wall of the vermiform appendix are the same whether they take place in the metropolis or the smallest village, but the problem of halting these processes before they endanger life may differ in the country and in the city. The mortality from appendicitis is said to be higher in the country than in the city. There may be reasons for this for which the rural surgeon is not to blame. The cases which I have used as a basis for this paper were all treated in the rural hospital and any conclusions which may be drawn from them will bear directly on the problem as we see it in rural and small town practice.

Before launching into a maelstrom of statistics, I would like to pause for a moment to do the "little assassin" as Deaver was wont to call the vermiform appendix, the honor of briefly reviewing its history. Royster,[3] in his monograph on "Appendicitis," says that the appendix was recognized anatomically in the sixteenth century, pathologically in the eighteenth century, but that clinically it is a product of the ninteteenth century. It is true that Saraceous, in a letter dated August 28, 1642, described an abscess in the right iliac fossa, with discharge of fecal material and that this was undoubtedly from a perforated appendix, but the credit for the first reported case is usually given to Mistivier, who in 1759 drained a pint of pus from the right iliac fossa and at autopsy found a large rusty pin in the vermiform appendix. The literature is replete with interesting episodes reported by early observers, all of which helped lay the foundation for the surgical attack which was to follow. As in all problems in surgery, the answer was not found until the pathological process was understood. The early workers considered that the disease began in the cecum and spread to the appendix. Kelly and Hurdon[4] state that Volz, in 1843, concluded that the appendix was at fault in affections of the right iliac fossa, more than was the cecum. The first operations were simple drainage and some modern surgeons or pseudosurgeons might take a lesson from this and restrict their activities to simple drainage until they have mastered the technic of removing the organ from the midst of coils of plastered intestine without breaking down nature's wall of protection. Simple drainage remains the procedure of choice in large appendiceal abscesses, in which the appendix is not easily accessible and its removal would result in contamination of the general peritoneal cavity.

Who first removed the appendix at operation, I do not know, but it is true that to American medical men goes the credit for the rapid advances in treatment of inflammation of the appendix made during the latter part of the nineteenth century. Reginald H. Fitz,[5] of Boston, read his paper on "Perforating Inflammation of the Vermiform Appendix" before the Association of American Physicians in 1886. He described the different results of perforation of the appendix, namely, general peritonitis and appendiceal abscess. He warned of the dangers if not treated and advocated early operation. Following publication of Fitz's paper in the American

Journal of the Medical Sciences, operations for the removal of the appendix became more and more frequent and were done with more confidence. McBurney[6] read a paper before the Medical Society of the State of New York in 1891, in which he reported twenty-four early operations in serious cases with only one death. Deaver states that the work of McBurney, Richardson, Murphy, Price, Fowler, Morris and others has added greatly to our knowledge of the subject and aided physician and surgeon in coping with the disease in a satisfactory and life saving manner. Deaver's own name must be added to those who by example and precept have established the fact that appendicitis is a disease with only one treatment and that surgical. It is fitting that the names of these men should be perpetuated through the names of instruments and technics in appendiceal surgery. If we are confronted with a case of appendiceal abscess we will probably open the abdomen through a McBurney incision, retract the margins of the wound with Richardson retractors, later use Deaver retractors after the placing of packing sponges, insert Morris drains and after the patient returns to bed place him in the Fowler position. If he is unfortunate enough to develop a fecal fistula which is resistant to closure, we may resect a section of the bowel and if there is reason for shortening the operative procedure, anastomose it with a Murphy button.

The management of the acutely inflamed appendix involves two equally important factors, diagnosis and treatment. Success in this management is more likely to be achieved if both are early. Obviously, early treatment is dependent upon early diagnosis. The responsibility for early diagnosis lies more often than not with the medical man rather than the surgeon. Frequently, the surgeon has no opportunity to share the responsibility unless he is invited. All too often the physician thinks of the surgeon as a technician to be called upon only if an operation is to be done; yet he himself has either never developed the ability for or has lost his interest in the careful and painstaking diagnosis of appendicitis. This places the patient in a not altogether enviable position. Reginald Fitz,[7] himself an internist, and a son of the man who read the paper on appendicitis before the Association of American Physicians, comments on the lack of interest in appendicitis among physicians, in a paper entitled, "The Challenge of Appendicitis," published in 1939. He states that in the past fifty years only six papers on appendicitis have been read before the Association of American Physicians, while in the same period about ten times that many have been presented before the American Surgical Association. Alvarez's,[8] "An Introduction to Gastroenterology" has gone through three editions. This beautifully written discussion of the mechanics of the digestive tract in health and disease is among my most prized possessions and yet I am astounded when I note that he dismisses appendicitis with a few short paragraphs. In these he describes the case of a young woman who had a ruptured appendix and did not vomit. He infers that this is a most unusual circumstance. Six such cases are included in the small group analyzed in this paper.

The basis for the remainder of this paper is a series of one hundred consecutive cases of acute suppurative appendicitis treated on my service and upon which I have operated in the ten years since I entered private practice. From about 160 charts of cases diagnosed preoperatively as acute appendicitis I have eliminated all those in which the pathologist's diagnosis or the gross appearance did not justify the final classification as acute suppurative appendicitis, including of course the cases which had reached the more advanced stages, such as gangrene or perforation. The great majority of these patients were operated upon in a thirty-five-bed hospital in a town of 5,000 inhabitants and the pathological diagnoses were made at the

Memorial Hospital in New York City. The remaining patients were operated upon in a fifty-bed hospital in a neighboring town of 5,000 and the pathological diagnoses made by the hospital pathologist. The patients were referred mostly by general practioners in the two communities and came from the two towns, the surrounding farms and from summer colonies at several resort lakes. All cases of acute catarrhal appendicitis and those diagnosed by the pathologist as simple acute appendicitis, subacute appendicitis and chronic appendicitis have been omitted. There were no deaths among these, so they might be used to lower the mortality rate in a study of all patients operated upon. One hundred cases of acute appendicitis with pus or gangrene remain for our consideration. Twenty-five of these had perforated with a resulting peritonitis of greater or lesser degree. The data from these charts were tabulated and will be discussed under the general headings of diagnosis, prognosis and treatment.

DIAGNOSIS

Muller taught at the University of Pennsylvania that the symptoms of acute appendicitis in the order of their appearance were: pain, tenderness, rigidity, vomiting, rapid pulse, fever and leucocytosis.

Pain was present in all of the one hundred cases and was the only constant symptom. It was described as follows in the histories:

	No. of Cases
Slight	35
Moderate	41
Severe	24

The locality of the pain varied, but the two most characteristic locations were around or above the umbilicus and shifting to the right lower quadrant or beginning originally in the right lower quadrant.

Tenderness was present in ninety-eight of the cases and I consider it a more important symptom on which to make the diagnosis than pain. I refer of course to tenderness in the right lower quadrant. The point of maximum tenderness was usually, although not invariably at McBurney's point, which lies on a line between the anterior superior spine of the right ilium and the umbilicus and about one and one-half to two inches from the ilium, depending upon the size of the patient. In this series of cases the tenderness was qualified as follows:

	No. of Cases
Absent	2
Slight	19
Moderate	31
Extreme	48

Tenderness is best elicited by exerting gentle pressure at first and it is well to begin this pressure at some other point than McBurney's, even on the left side. If there is real tenderness, the patient will usually mention it without any questioning or it can be detected by facial or abdominal reactions or a flexed right thigh. These observations bear more weight than verbal answers for it is a very stoical individual who can mask the pain when pressure is made at McBurney's point over an acutely inflamed appendix. A verbal declaration of tenderness coming from a grinning face usually fails to elicit much sympathy from me when unaccompanied by some other physical confirmation. It is not good for one's reputation to operate for ticklishness.

Rigidity was a close third, being present in ninety-two cases. This may be a difficult sign to evaluate, but it is worthy of careful consideration. It is so dependent upon the position of the inflamed organ that it is subject to wide variations. Do not expect it to be extreme, but take its presence seriously in any degree. These records showed it to exist in the following degrees:

	No. of Cases
Absent	8
Slight	41
Moderate	32
Extreme	19

These are the three cardinal symptoms of appendicitis, pain, tenderness and rigid-

ity. Look for the others, but make your diagnosis on these. You will seldom be wrong.

Fifty-seven of these patients *vomited.* In addition, nineteen others were nauseated, making a total of seventy-six who were "sick at the stomach." This is a symptom which cannot be neglected and when associated with abdominal pain is of major significance.

Rapid Pulse. I took 75 as the normal and seventy-nine of these patients had pulse rates above this. *Fever* was present in eighty-five. These are seen to be frequent signs, but do not expect them to be marked, especially the fever. If it is high, consider carefully the other abdominal conditions and look outside the abdomen. You may be rewarded with the opportunity to make a brilliant diagnosis.

Blood counts were done in ninety-five of these cases and ninety of them had *leucocytosis,* considering 10,000 white blood cells as the upper limit of normal. Only ten of the ninety-five were below 12,000. The five patients with normal white blood counts were all males and four of them were past fifty years of age. Three of these four had elevated polymorphonuclear counts. Differential counts were done in seventy-three of the cases, sixty-nine having polymorphonuclear counts above 70 per cent; fifty-six or more than half had polymorphonuclear counts above 80 per cent, and fourteen above 90 per cent. The total white blood counts were very high in both patients who died. The polymorphonuclear count was high in one and not done in the other.

To Muller's classification of symptoms I have added diarrhea and constipation, for I was curious about these. Fourteen had diarrhea and fifteen were constipated, either chronically or prior to the attack. Do not be led astray by the presence of diarrhea; look for a pelvic appendix.

Pelvic or rectal examinations were recorded in only forty-two of these cases. The findings were positive for a mass or right pelvic tenderness in thirty-three or 75 per cent; fourteen of these were females. Pelvix tenderness in a female patient does not always mean salpingitis. If it is present on the right side, go back and review the other signs and symptoms, before referring the patient to the gynecologist. Extreme tenderness may be found on pelvic or rectal examination when the tenderness at McBurney's point is negligible. It may be the deciding factor between operation or noninterference in a very acute case of appendicitis. Pelvic or rectal examination should be done routinely or at least when the other findings are not convincing. Appendicitis is no exception to the rule that a sick person deserves a complete examination.

PROGNOSIS

The time of onset is of great importance. In the opinion of many, it should radically influence the treatment. This is debatable, but all agree that it definitely alters the prognosis. In the two deaths in this series, the onset preceded operation by forty-eight hours or more. Larger series of statistics invariably show that delay increases the mortality. The necessity for drainage is one criterion of the seriousness of the case as seen at operation. Following is a grouping of these cases with regard to time of operation and whether or not, in the opinion of the operator, drainage was indicated:

Time of Operation Following Onset	Number	Drained, Number	Per Cent
Under 24 hours.....	31	7	22.9
24 to 48 hours.....	45	21	46.6
Over 48 hours.....	24	24	100.0

The taking of laxatives at the time of or following onset influences the prognosis. Deaver used to teach that purgation and perforation were almost synonymous. He enjoyed quoting the following verse:

"Purgation means perforation
In an appendix kinked and bad.
Food and drink worry him,
And aperients drive him mad."

Twenty-two of this series are known to have had laxatives. Six of these had demonstrable abscesses or peritonitis. In eight others the appendix was gangrenous or necrotic. Probably some of the others who had perforated appendices had taken laxatives, but did not admit it, when the history was taken. One young woman apologized for it, but said her mother had urged her to take the laxative.

TREATMENT

There is only one treatment—*operation*. The optimum time for this, in certain cases, is still being debated by eminent authorities. Any patient with acute appendicitis admitted to a hospital and not operated upon, should probably be classified in the final filing as untreated. With the exception of three cases, all the patients in this series were operated upon without delay. Operation was delayed in two of these because of an uncertain diagnosis and in one because the patient refused it for three days. Her obstinacy was rewarded with an appendiceal abscess and a prolonged hospital stay.

The question of anesthesia is one of importance. In the small rural hospital its choice may depend upon factors that do not come up for consideration in the large and completely staffed institution. In this series spinal anesthesia was used in seventeen cases, general in thirty-three and avertin with general in fifty. If operation must be done without the services of a physician versed in anesthesia or a competent nurse anesthetist and the surgeon has had training and experience in the use of spinal anesthesia, I believe that form is the method of choice. It should not be used, however, without careful observation of the patient during operation, either by a physician or a dependable nurse who will report immediately any change in the patient's condition. The various means of combating the rare untoward symptoms resulting from spinal anesthesia should be available and the surgeon should be acquainted with their use. The anesthesia of my choice, for most appendiceal surgery, is avertin, with a maximum of 70 mg. per kilo of body weight, supplemented with nitrous oxide and oxygen. In the very sick and toxic cases I sometimes prefer open drop ether. I agree, however, with the advocates of spinal anesthesia that it simplifies the operative technic. It has definite indications in selected cases and under certain circumstances. The surgeon contemplating rural practice should make a very special point of acquainting himself with the use of spinal anesthesia. Sooner or later he will find himself in a situation in which it is by far the best and safest method.

The approach to the appendix is usually through a right rectus, muscle retracting incision or a gridiron, muscle splitting incision. The former is usually referred to as the Kammerer and the latter as the McBurney, although first described by McArthur. The right rectus incision may be varied by retracting the muscle laterally, rather than medially, as Kammerer did, or by splitting the fibers. In this series of cases the McBurney incision was used seventy-eight times, the right rectus twenty-one times and the transverse incision of Davis once. The use of the right rectus incision was mostly in the first few years of the period covered by this study. I became more and more convinced, that especially when operating with only one assistant, as we usually do in the small hospital, the McBurney incision reduced the technical difficulties to a minimum. It has many advantages which are obvious to those who have given it an adequate trial. It is quicker, easier, more direct, safer, provides a better channel for drainage and due to its not destroying blood or nerve supply, it is less likely to result in postoperative hernia. The opponents of this incision, who all too often have not tried it, argue that it is not satisfactory for exploration. We are operating for acute appendicitis, when we use this incision, not to palpate the spleen. Lahey,[9] who is not an opponent of the muscle splitting

incision of McBurney, but who prefers the right rectus approach, states, "In the surgical management of acute appendicitis we are concerned with a low mortality rate, with not spreading the infection, with visualization of the acutely inflamed appendix and its removal, and with as little manipulation of the surrounding coils of intestine as possible, and to do this it is essential to have an incision of adequate length to permit wide exposure." To this I would add that the incision must be anatomically placed and we have a convincing case for the McBurney incision. If we adhere to sound surgical principles, we try to prevent contamination of any part of the peritoneal cavity beyond the right iliac fossa. This may be difficult when the approach is across the coils of the small intestine, which are likely to present themselves in the right rectus incision. If we have erred in our diagnosis and want to explore, this can be done, within limits, through the McBurney incision, especially with the use of the Weir extension, which involves incising the rectus sheath and retracting the rectus muscle medially. On a rare occasion when the diagnosis is so far off as to require extensive procedures in distant parts of the abdomen, the McBurney incision may be quickly closed and another incision made over the site of the pathological process. In such cases the low right rectus incision may very likely have proved inadequate also.

A certain female patient died from peritonitis following an appendectomy through a right rectus incision in a prominent New York hospital. It was the incision taught on the service where the surgeon was trained. A member of a rival service remarked that if she had had a McBurney incision she would not have died. That would be difficult to prove, but Mont Reid,[10] in 1934, reported a 50 per cent decrease in the mortality from acute appendicitis in the Cincinnati General Hospital after the adoption of the McBurney incision in place of the right rectus. All I ask is that the proponents of the right rectus incision try the McBurney in ten consecutive cases of acute appendicitis.

Another matter of technic of special interest to the surgeon dealing with appendicitis is the treatment of the stump. I prefer to remove the appendix with the actual cautery, thoroughly cauterizing the stump, but I have no argument with those who prefer the phenol and alcohol treatment. The modern cautery, with boilable cord, handle and tip, make the use of the cumbersome draping of the cautery handle, with its attendent opportunities for contamination, unnecessary. After treatment of the ligated stump, it may be dropped back into the iliac fossa or buried with a previously inserted purse-string suture. It is incorrect to refer to this as inverting the stump, if the base of the appendix has been securely tied, prior to the removal of the organ. It is rather burying the stump in a pocket created in the wall of the cecal head. True inversion, as described by Ochsner and Lilly,[11] is the burying of the crushed, but unligated stump, so that the edges of the small collar of the appendix which remains will actually invert into the lumen of the bowel. They present a very good brief for this technic and I am convinced that carefully done it is the safest and most rational method of dealing with the stump. However, it is not a method to be tried with the casual or occasional assistant and this is the type of assistant we may have in the rural hospital. If he allows the base to escape from the grasp of his forceps, the field may be soiled with intestinal contents.

A happy medium between the secure ligature of the base and true inversion is the use of a single knot, plain gut ligature, cut close, before inversion. Any amount of purulent material which forms in the wall of the cecum, will by its own pressure untie the single knot and empty itself harmlessly into the lumen of the bowel. I devised this technique after reading the paper by Ochsner and Lilly and have used it with a feeling of security since then.

Jones[12] described a similar technic in 1940. He modified the method of Lenander, as described by Kelly and Hurdon,[4] in which a temporary loop of suture material was placed around the base of the appendix, but removed before inversion of the stump. Jones grasps both strands of the loop ligature with the tip of a fine hemostat, close to the appendix. He inserts the purse-string suture, removes the appendix, which is clamped just distal to the loop and treats the stump with carbolic acid and alcohol. He then cuts the two ends of the loop ligature flush with the end of the hemostat and inverts the stump through the purse-string suture. He then releases the hemostat and tightens the purse string. Following this he reinforces the area with a silk mattress suture and presses the buried stump between the thumb and forefinger to open it and reinforces the suture line by suturing the stump of the meso-appendix over it.

The question of drainage following the removal of the perforated or gangrenous appendix is one that requires considerable surgical judgment. Fifty-three of these wounds were drained; twenty-five of the patients having drains had ruptured appendices. Discussion of the criteria for drainage in a paper of this kind, would be almost useless, for each individual case must be considered on its own merits. It might be well, however, to make the bold statement, "When in doubt, don't drain." This is contrary to the teaching of fifteen or even ten years ago, but is in accordance with the best surgical thought of today. This is especially true since the introduction of the sulfa drugs. Since the majority of these patients were operated upon before the widespread use of sulfa drugs in the peritoneal cavity, these aids were not used in many. However, in the later cases, sulfanilamide was introduced intraperitoneally in some and into the layers of the wound when wound contamination was feared. Sulfathiazole was reserved for systemic treatment, either orally or parenterally.

It would be missing an opportunity in the discussion of the technic of the operation for appendicitis, not to stress the need for extreme care and attention to details. Speed is of little consequence. The time for speed is in making the diagnosis and getting the patient to the operating table. I believe in trying to eliminate lost motion, but most motions may well be made deliberately and with extreme care. It is both discouraging and disgusting, when one has freed an adherent and gangrenous appendix with no soiling, to have the assistant wipe it across the edge of a fat wound margin, thus inviting a wound abscess. It will pay to have taken time to protect the wound edges with gauze and to have instructed the assistant as to what you expect of him.

The assistant plays a very important rôle in any operation. Occasionally, his move is the most important one and the operator must not forget to assist him. It is well if the assistant has had some surgical training, but in any event he must be interested in the technic of the operation and take every opportunity to improve his own technic. Too many assistants think of themselves only as sterile hod carriers for a high priced brick layer and in so doing they often cease to be sterile. In rural practice, as well as in the city, the patient is safest in the hands of a well trained operating team. If residents are not available, it is well to make use of members of the staff who show interest in and aptitude for surgical technic. Smooth team work requires working together and this is certainly every bit as important in the removal of an appendix as it is in scoring a touchdown or completing a triple play.

The operating room nurses, both the scrub nurse and the circulating nurse, should think of themselves as members of the operating team. They should make themselves acquainted with the technic and methods of each operator and anticipate his needs, so that he does not have to break his train of thought, which is the guide to his technic. A scrub nurse should

have more than a speaking acquaintance with anatomy, so that she can intelligently follow the steps of the operation. It is one of the duties of the surgeon to take every opportunity to instruct her in this, in order that her knowledge of and interest in anatomy will increase.

I have offered a plea for more interest in appendicitis on the part of the physician, even though it may not fall to his lot to take the leading rôle in the most dramatic part of the treatment. I must not close without mention of consultations. The surgical consultant should be called often and early in suspected appendicitis, but should not necessarily recommend operation. So often the surgeon is called when the need for operation is evident to everyone in the house and the optimum time for operation is past. Physicians and surgeons alike are responsible for this. When all surgeons begin to consider themselves as students of surgery and not just operators and physicians begin to recognize them as such, the mortality rate from appendicitis will drop. An intelligent discussion of a case of abdominal pain and a painstaking explanation of why operation is not indicated will gain more respect, if not fame, for the surgeon than the blunt statement, "She must be rushed to the hospital." Of course I do not advocate this explanation when operation is indicated. One of the patients in this series, who died, was seen by one physician who did not go back to see him after his first examination. He was seen by another physician on the third day and surgical consultation was then asked for. He had peritonitis complicated by diabetes mellitus. The other patient had his onset one evening, was seen by a physician the following day and surgical consultation asked for twenty-four hours later. This was forty-eight hours after the onset. His appendix had not perforated, but the disease was far advanced.

Dennis[13] discussed consultations in appendicitus very intelligently, in a paper read before the Kings County Medical Society, (Brooklyn) in 1903. He said, "Beside the duty which belongs to the family physician, and the duty which develops upon the practical surgeon, there is still a common reciprocal duty which belongs to both. The mortality in appendicitis can be reduced only by a hearty, cordial co-operation of both physician and surgeon, and when these relations are established, the death rate, small as it is, will be still further reduced, and both physician and surgeon can, by united action, contribute to the comfort and salvation of the patient. It is in this way only that the death rate can be reduced and until the family physician and practical surgeon meet on a common ground, and consult in perfect harmony, the death rate will remain where it is." That is as true now as it was thirty-nine years ago.

SUMMARY

The history of appendicitis has been briefly reviewed and a plea made for a renewed interest in this disease on the part of all physicians.

A series of one hundred consecutive cases of acute suppurative appendicitis, with two deaths, has been presented. In twenty-five of these the appendix had perforated with one death—a mortality rate of 4.0 per cent. In the seventy-five cases without perforation there was one death—a mortality rate of 1.33 per cent. The mortality rate for the entire series was 2.0 per cent.

These attacks occurred for the most part in young and middle aged patients, 70 per cent being less than thirty years old and 80 per cent less than forty.

The symptoms as seen in this series have been presented as follows: pain, tenderness, rigidity, vomiting, rapid pulse, fever, leucocytosis, diarrhea and constipation. The constant presence of pain, although not usually severe, and the overwhelming frequency of tenderness and rigidity have been pointed out. Nausea and vomiting in

association with abdominal pain have been emphasized as of major significance.

The importance of early diagnosis and operation and their relationship to mortality and morbidity has been stressed.

The danger of laxatives has been reiterated.

Treatment has been discussed with a plea for early operation.

The advantages of certain points in technic have been mentioned.

A frank statement of the need for more and earlier consultations in suspected appendicitis and a discussion of the responsibilities of both physician and surgeon have been presented.

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PREOPERATIVE HEMO-IRRADIATIONS

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PREOPERATIVE protection by the Knott technic of ultraviolet blood irradiation therapy has been studied for the past five years at Shadyside Hospital in Pittsburgh. Since 1937, approximately 4,500 ultraviolet blood irradiations have been administered to about 1,500 patients. Those cases in which this therapy was administered preoperatively followed a subsequent postoperative course that merited a detailed study of its use as a protective preoperative measure.

This therapy has been used for the successful treatment of different types of septicemias as reported by Hancock and Knott,[1] Barrett,[2] Miley,[7] Rebbeck,[3–6] Miley and Rebbeck,[8] and Hancock.[9] The rationale of ultraviolet blood irradiation therapy and the known reactions taking place following administration in cases of septicemia indicated it should prevent the development of septicemia. Further the known reactions and rationale indicated that definite protection should be afforded the patient against postoperative reactions when the operative risk is of questionable nature.

The primary field of clinical investigations was that of incomplete septic abortion as reported by the author. This paper described a radical and successful treatment consisting of preoperative ultraviolet blood irradiation therapy followed by dilatation and curettage, using a sharp curet as in clean cases. Our experiences in other pathological conditions show that ultraviolet blood irradiation therapy used preoperatively is a safe procedure, permitting radical and advantageous departure from conventional treatment of at least the following diseases and in the following manner:

1. *Acute Rheumatic Fever and Rheumatic Arthritis.* Tonsillectomy and adenoidectomy as well as teeth extractions in the early acute febrile stage.

2. *Multiple teeth extractions* in bad risks from the standpoint of mouth sepsis and cardiac conditions, particularly coronary thrombosis.

3. *Bad Thyroid Risks.* Partial or complete thyroidectomy in one stage.

4. *Incomplete Septic Abortions.* Prompt dilatation and curettage in the febrile stage.

5. *Acute Cholecystitis.* Immediate cholecystectomy.

6. *Lymphangiitis, Lymphadenitis, Cellulitis.* Early localization or disappearance of the infected process.

Acute rheumatic fever with diseased tonsils or abscessed teeth as the focus of infection often present serious problems in treatment. The physician generally has to treat conservatively, fearful of setting up septicemia or a local spread of sepsis by resorting to surgery in the acute febrile stage. Often the result is that by the time it is considered safe to remove these foci the heart has been irreparably damaged.

Frequently the surgeon is faced with a toxic goiter in which the response to preoperative treatment is unsatisfactory, i.e., the basal rate cannot be brought down to a sufficiently low level to be considered safe for operation, or in an elderly patient with toxic adenomas and a bad cardiac risk.

A case of acute suppurative cholecystitis that the best clinical data indicate should be treated conservatively for twenty-four to forty-eight hours to avoid so-called liver shock, which could during this period sustain even more bile duct and liver damage from the infected gallbladder.

In septic abortion because of well grounded fears of spreading infection locally and even breaking down barriers to

produce septicemia, the surgeon is fearful of cleaning out the uterus with resulting pelvic disorders necessitating later pelvic surgery or even death from septicemia, not to mention the incidence of sterility.

Acute cellulitis with lymphangiitis and lymphadenitis can be a very dangerous problem and in some instances will progress to septicemia.

The foregoing are a few of the pathological conditions which we have observed to have responded very nicely to preoperative blood irradiation therapy and made surgical intervention possible with gratifying results at a much earlier date than routine treatment would allow.

The procedure of administration of ultraviolet blood irradiation therapy has been described by Miley,[10] and briefly consists of the withdrawal of a portion of the patient's venous blood, citrating it and exposing it to ultraviolet rays of specified wave lengths and intensity for a definite period of time and returning it to the patient.

The following are some types of cases treated for preoperative protection and the results obtained:

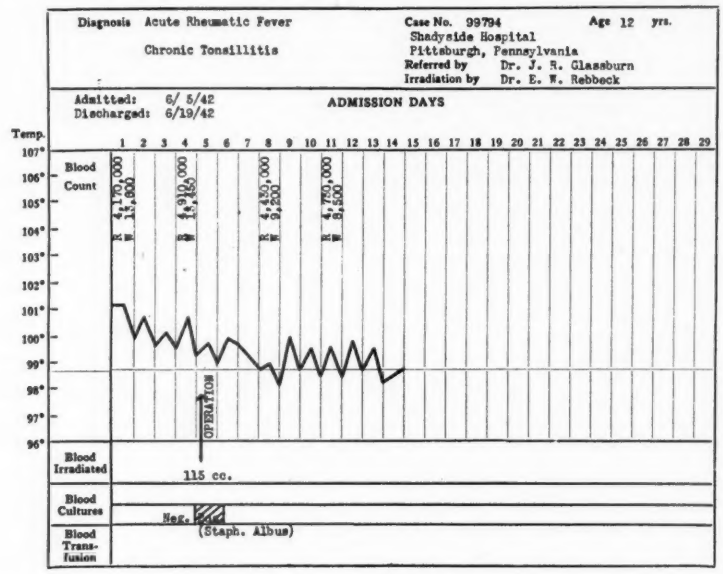

FIG. 1. A, Case 1.

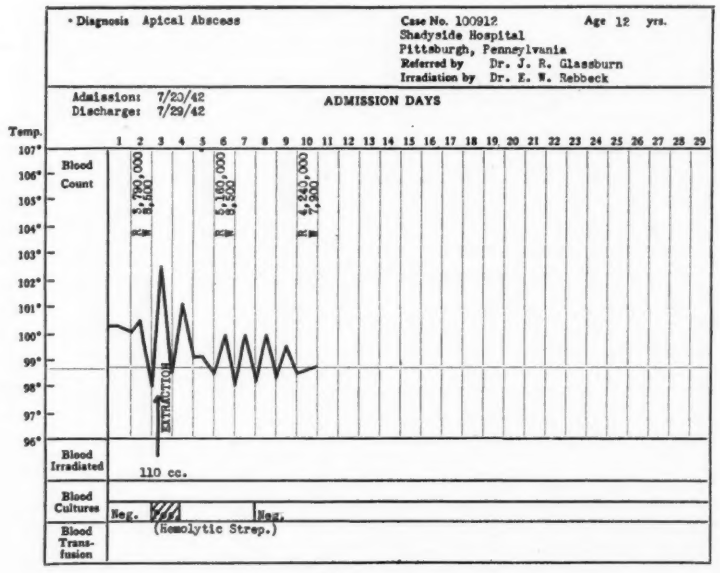

FIG. 1B.

CASE REPORTS

CASE 1. No. 99794. Miss G. gave a history of shifting joint pains with swelling, tenderness, and fever for three days prior to admission. It was decided that the tonsils were the cause of this acute rheumatic fever. On the fifth day of her acute illness preoperative blood irradiation was given followed in one hour by tonsillectomy. A transient Staphylococcus albus appeared in her blood stream immediately after operation. No untoward symptoms developed. Her sedimentation dropped from 76 mm. in one hour to 12 mm. in one hour. On the sixth postoperative day joint symptoms had completely disappeared. The systolic mitral murmur which had been present before operation disappeared. She was sent home on the ninth postoperative day in good condition.

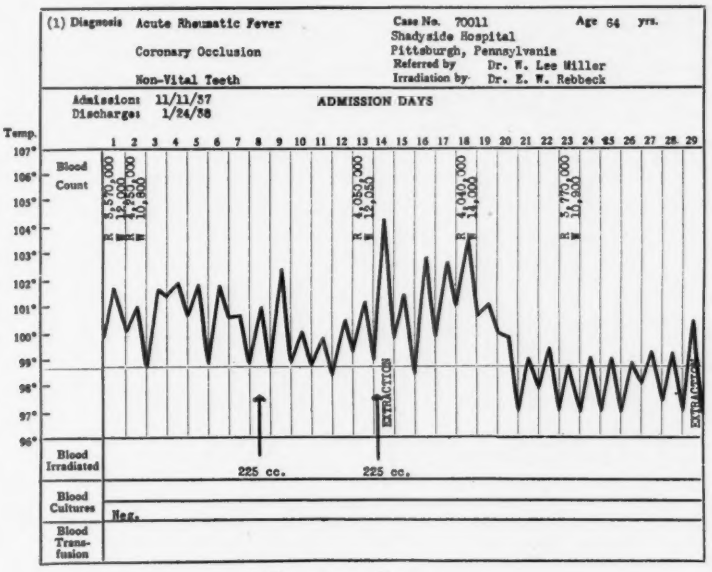

FIG. 2. A, Case II.

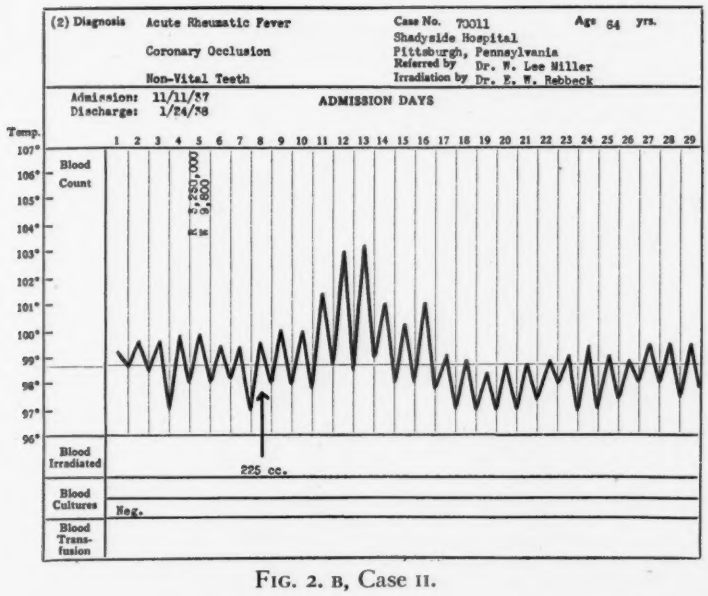

FIG. 2. B, Case II.

One month later a peri-apical abscess of the lower left first molar developed, and her joint symptoms began to recur. She was readmitted. Another preoperative blood irradiation was given. The tooth extracted, and this time a transient hemolytic streptococcus appeared in her blood. However, she convalesced uneventfully and was discharged on the eighth postoperative day completely free from heart complication and joint symptoms.

Extraction after irradiation affords the patient only mild discomfort and healing is accelerated. When one considers the usual conservative method of handling these cases in which so many heart lesions of prominent nature develop, the protection afforded by ultraviolet blood irradiation therapy used preoperatively merits intensive study.

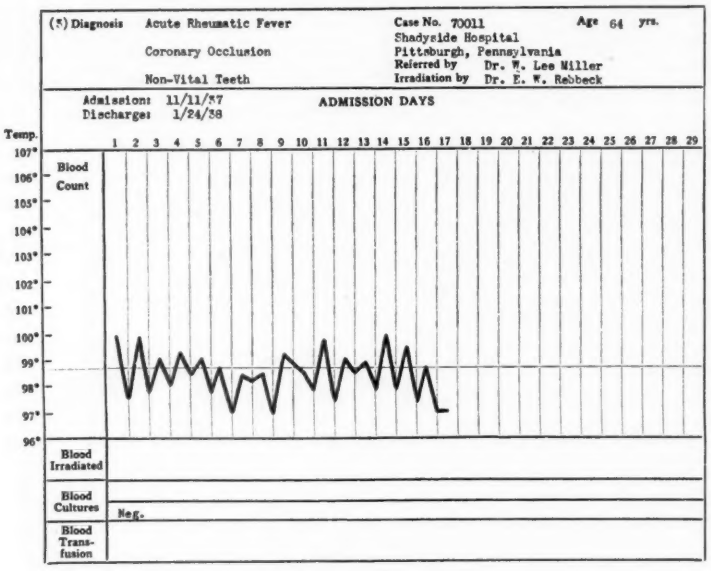

FIG. 2. C, Case II.

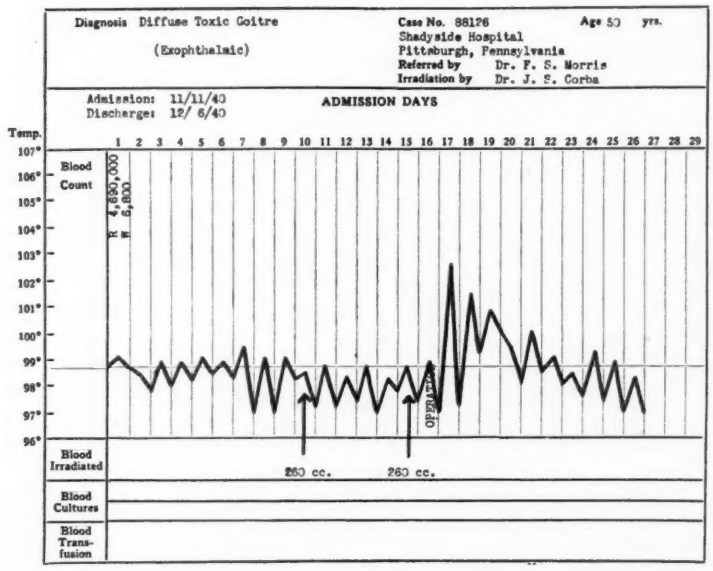

FIG. 3. Case III.

CASE II. No. 70011. Mr. G. suffered an attack of coronary occlusion on November 11, 1937, which was considerably relieved the next day, but acute rheumatic fever supervened on this date, became progressively worse and complicated by a septic state which by November 18th, presented a semiconscious patient with a temperature of 101°F., pulse 104, although his blood urea maximum was only 14.4 mg. The patient had a very septic condition of his gums and teeth with nine retained roots in the lower jaw, six nonvital teeth with retained roots in the upper jaw. Blood irradiation therapy was instituted on November 18th. Within three days his joint symptoms had practically subsided. He was mentally alert. His temperature had subsided to 99°F. With joint symptoms recurring progressively worse the next three days it was decided that in view of the septic mouth condition being the

probable focus of his rheumatic fever, extraction was the only possible means of relief. Blood irradiation therapy was again given on November 24th, and the six teeth in his upper undoubtedly was a life saving measure in this instance. When last heard of this patient was working at his engineering occupation in August, 1938.

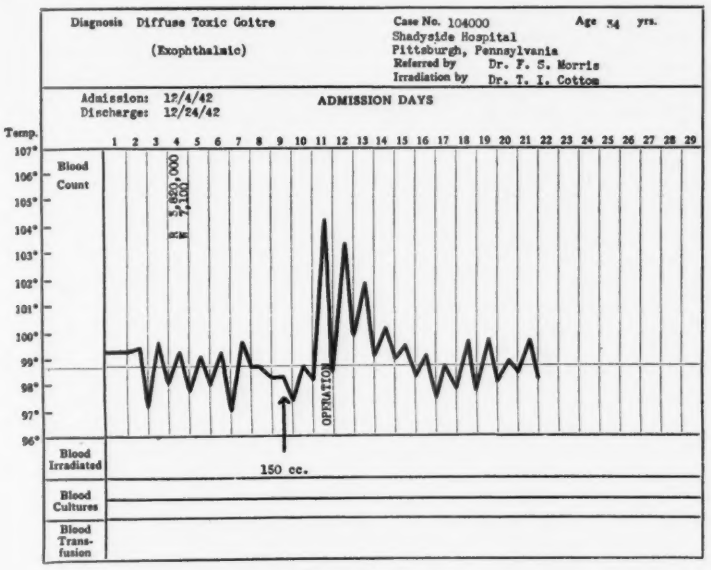

FIG. 4. Case IV.

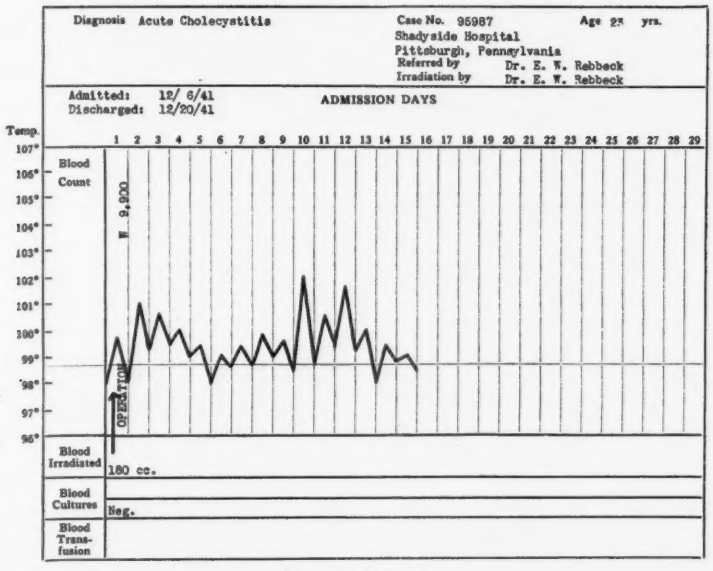

FIG. 5. Case V.

mouth extracted. His peak reaction to this extraction was 103°F. temperature, pulse 120. However, no positive blood cultures were obtained. On December 9th, the remaining nine teeth were extracted, and the peak reaction was 100.4°F., pulse 100. Blood irradiation therapy was again performed on December 17th. The patient was discharged on January 24, 1938, in good general condition. This radical departure in the way of extracting teeth in the presence of acute theumatic fever

CASE III. No. 88126. Mr. B. had a basal rate on November 11, 1940, plus 86, and plus 62 on November 18th, and plus 62 on November 22nd. Despite rest in bed, Lugol's therapy and phenobarbital. His pulse rate ranged up to a peak of 118. He received blood irradiation therapy on November 20th, and again on November 25th. A thyroid resection was performed on November 27th. His peak reaction was 102.6°F., pulse 136 which had subsided to 99.4°F. temperature and pulse 90 within

forty-eight hours. He was discharged in good condition on December 6, 1940.

Our experience has shown in several other similar cases that preoperative blood

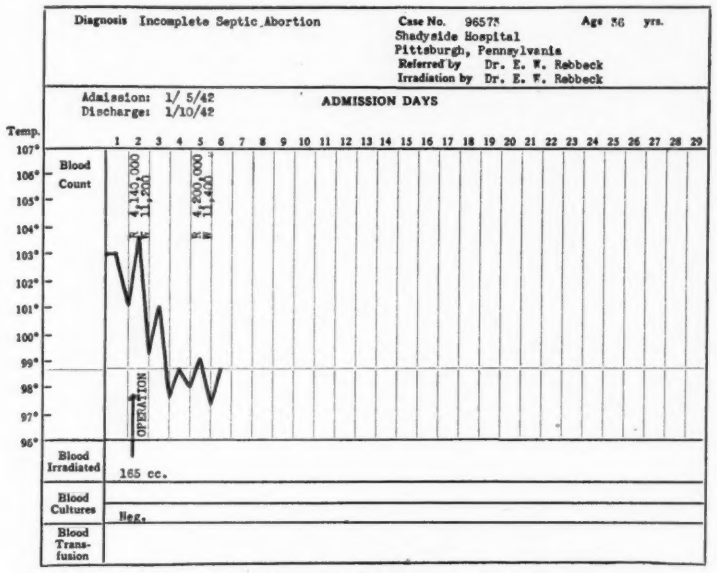

Fig. 6. Case VI.

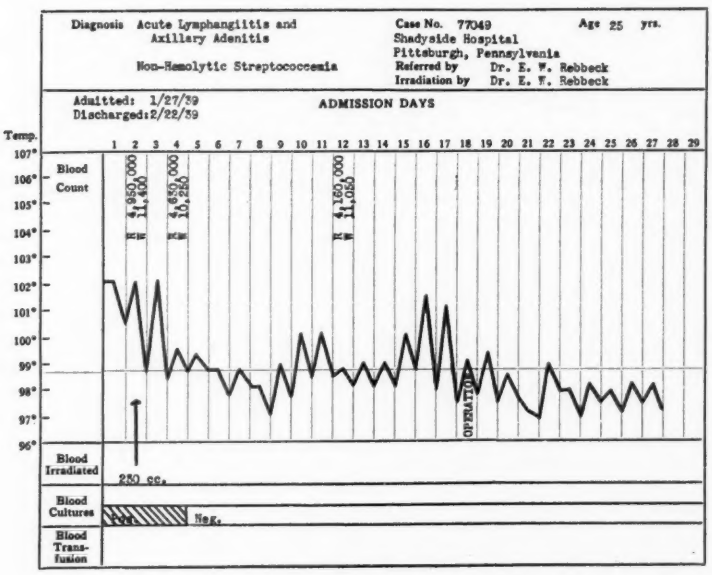

Fig. 7. Case VII.

irradiation affords definite protection to this type of goiter which does not respond to preoperative iodine therapy.

Case IV. No. 10-4000. Miss Y. had a basal rate of plus 76 on December 4, 1942, plus 86 on December 9th, despite rest in bed, Lugol's solution and phenobarbital. Her pulse rate averaged up to 140. She was quite nervous and restless. Preoperative blood irradiation therapy was given on December 12th, and thyroid resection performed on December 14th. Her peak reaction was a temperature of 104.2°F., pulse 104, and within forty-eight hours her temperature had dropped to 100°F., pulse 84, peak. She progressed to normal convalescence and was discharged on December 24, 1942. Her basal rate on January 4, 1943, was minus one, and pathological diagnosis, diffuse toxic goiter (exophthalmic).

This type of goiter, we believe, would be a very precarious operative risk particularly for a one-stage operation.

Case V. No. 95987. Mrs. P. had an attack of acute cholecystitis and was operated approximately ten hours after her attack began. She

was given preoperative blood irradiation therapy. At operation an enormously distended gallbladder was found with quite thick edematous walls and a stone impacted in the cystic duct. As yet the bile was clear.

In this type of case it is our belief from experience in other patients that if some means is afforded to proceed safely with immediate operation, much less damage is apt to result to the bile ducts and cells of the liver. With the exception of an occasional atelectasis no detrimental reactions have been observed in performing immediate operation in acute cholecystitis. From a period beginning December, 1941, through September, 1942, no atelectasis developed in our surgery, and it is our opinion that this sequel did not occur, despite spinal anesthesia, because these patients were treated by postural lung drainage and careful attention was paid to deep breathing postoperatively (in other words we raised the backrest in all cases approximately thirty degrees immediately after operation). Incidentally, no headaches were observed.

We also believed that the bad operative risk, particularly the toxic cases and elderly patients with serious cardiac conditions, went through their operation much better because they were given blood irradiation therapy before operation.

CASE VI. No. 96573. Mrs. C. admitted taking quinine and using a slippery elm stick to produce abortion. She was pregnant about six weeks. Her bleeding on admission was scant, temperature 103°F., pulse 130. The next morning blood irradiation therapy was given and immediately dilatation and curettage performed using placental forceps and a sharp curet. Tissue examination showed necrotizing placental tissue. Her convalescence was uneventful. She was discharged on the fourth postoperative day in good condition.

This type of patient is dangerous to operate upon in this way both from the standpoint of local spread of infection and septicemia. Blood irradiation has been a remarkable protective therapy for these patients.

CASE VII. No. 77049. Mr. J. was admitted with a marked lymphangiitis and axillary adenitis involving the right wrist and arm which occurred from squeezing a small pustule on his wrist. A blood culture taken on admission showed nonhemolytic streptococci. He had severe axillary pain necessitating morphine for its control. The next day blood irradiation was given. His temperature began to recede by lysis. Within twenty-four hours the pain was decidedly relieved; the streaks faded definitely and there was less swelling. Over the next ten days the axilla gradually softened to a point at which incision and drainage was indicated. The same organism was found in the cultured pus. The patient then progressed to an uneventful recovery.

We feel this is an instance frequently observed of localization of infection following blood irradiation. Subsequent blood cultures were negative. In many cases of such a pathological disorder of milder nature the inflammatory process has been seen to subside completely and usually within twenty-four to thirty-six hours.

The foregoing cases were selected for publications as examples of the reactions to surgery when ultraviolet blood irradiation therapy is administered preoperatively. Careful perusal of the charts and case histories show that a safe means of protection is afforded a poor operative risk by use of the Knott technic of ultraviolet blood irradiation therapy preoperatively in at least the pathological conditions mentioned. A marked decrease in the morbidity and mortality in these diseases has been accomplished.

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Case Reports

CERVICAL LESIONS OF BRANCHIAL ORIGIN*

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THE mode of origin and the surgical treatment of sinuses, fistulas and associated lesions located laterally in the cervical region have been the subject of considerable interest to surgeons. An opportunity to treat three patients with affections, presumably of branchial origin, brought the questions of diagnosis and therapy to our attention. One patient admitted with an apparently complete cervical sinus presented a particularly interesting surgical problem. The other two patients offered the simpler therapeutic task of the removal of the cervical auricles discovered during routine physical examinations.

It is generally believed that the view of Rabl[7] is correct that the lateral cervical sinuses, fistulas, cysts and auricles arise from the branchial clefts, usually the second. The branchial apparatus is present in the human embryo from the tenth to about the fortieth day of intra-uterine life. Wenglowski, a Russian surgeon, advanced a second view based upon an extremely careful and lengthy study of the embryology of the cervical region. His work has been reviewed at length by Meyer,[6] who has made it available in English. Wenglowski believed the unobliterated thymic duct gave rise to these congenital abnormalities. Bailey[1] points out that the existence of cartilaginous cervical auricles in the lower part of the neck cannot be explained according to the views of Wenglowski, who stated that branchial remains do not occur below the level of the hyoid bone. The cervical auricles are almost certainly of branchial origin.

The branchial sinuses and fistulas lie laterally in the neck. They may extend from the base of the skull, as illustrated by Case 1 of this report, to a point just above the clavicle medial to the sternocleidomastoid muscle. They are divided into three types by Bailey:[1] (1) complete fistulas with outer and inner openings, which are usually near the tonsillar fossae; (2) incomplete external sinuses with an outer opening only; and (3) incomplete internal sinuses with inner openings only. The last type is the most uncommon. Douglas[4] described a patient, who was able to distend his neck with air forced from the mouth into the track. The branchial cysts lie, as a rule, anterior to the sternocleidomastoid muscle in the upper portion of the neck. The cervical auricles are found just above the clavicle in close relation to the medial margin of the sternocleidomastoid muscle.

The sinuses and fistulas are lined with stratified squamous or columnar ciliated epithelium; lymphoid tissue and striated muscle are found in the deeper portions of their walls. The cysts present a similar structure with the epithelium commonly stratified squamous in type and with large masses of lymphoid tissue in the

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walls. The cervical auricles are composed of fibrous, elastic or hyaline cartilage.

The lesions of branchial origin are removed by operation because of signs of tumor, discharge, or recurrent infection and the possibility of neoplastic alteration. Ewing[5] states that the branchial remains may give rise to either chondromas or deep and often very malignant acanthomas of the neck. Carp and Stout[2] found four probable branchiogenic epithelial neoplasms in a group of 1,538 cancers. They point out, as do Cutler and Buschke,[3] that the diagnosis of branchiogenic carcinoma must not be made unless all possibilities of other primary origin especially in the nasopharynx have been excluded. Cutler and Buschke[3] believe that primary branchiogenic carcinomas are certainly very rare.

Complete surgical removal of the branchiogenic lesions is the ideal method of treatment. The attainment of this object may be quite simple as with the usual case of cervical auricle (Cases II and III). The close proximity of the more extensive lesions to the important cervical structures make their removal more difficult. Furthermore, the lesions are, in part, deeply seated and may be inaccessible for total removal. An incision parallel to the track of a sinus or fistula is commonly used. Bailey[1] has suggested, however, the employment of transverse incisions. After dissection has been carried from the lower incision at the skin opening of the track as high as possible, a second incision is made through which the operation may be completed.

The first case of this report is described in detail because of its interesting surgical aspects. The sinus track reached from above the clavicle to the base of the petrous portion of the temporal bone.

CASE REPORTS

CASE I. W. J., a twenty-five year old white soldier, was admitted April 4, 1942. For ten years the patient had been conscious of a small lump just above the inner end of the right clavicle. Two years previously the mass had been incised and clear fluid obtained. Since then drainage had been intermittent. No food particles had ever passed from the openings. The family history was without significance. Examination disclosed a fluctuant, nontender mass about 2.5 cm. in diameter at the anterior margin of the right sternocleidomastoid muscle just above its insertion into the clavicle. A small amount of purulent fluid could be expressed from small openings through the scar tissue over the mass. A firm narrow cord could be palpated running along the anterior aspect of the sternocleidomastoid muscle up to the level of the hyoid bone. The pharynx was not unusual and the right tonsil presented no abnormalities. The larynx appeared normal on indirect laryngoscopic examination. A diagnosis of lateral cervical sinus of branchiogenic origin was made.

April 10, 1942, with local anesthesia, the swelling was incised to provide adequate drainage, and a portion of skin and wall of a small cavity lined with mucous membrane was removed for pathological study. Histological examination of the tissue demonstrated a segment of epidermis, in which there was some hyperkeratosis and hypertrophy of the rete pegs with chronic inflammatory infiltration. Adjacent to this epidermis there was a zone of transition to a pseudocolumnar ciliated type of epithelium resembling that found in the nasal cavity. No mucous glands or goblet cells were seen. The presence of the two types of epithelium in tissue from this region was considered indicative of branchial origin. Culture of the pus demonstrated nonhemolytic staphylococcus aureus. Tubercle bacilli were not found in smears and no fungi grew on Sabouraud's medium.

The wound was treated with Dakin's solution. A probe could be passed 4 cm. up the track from the skin edge. Iodochloral was injected into the track, and roentgenograms (Fig. 1) showed it reaching from the second thoracic to the sixth cervical vertebra.

Operation was performed April 23, 1942, with an intratracheal tube in place. Open drop ether anesthesia was used with insufflation, when necessary, late in the operation. An incision encircling the scar tissue around the opening of the track at the base of the neck was extended upward along the anterior margin of the sternocleidomastoid muscle for 10 cm. The track itself was readily removed by sharp dis-

section from beneath the platysma muscle and from the sternocleidomastoid muscle. At the level of the hyoid bone, the track passed deep

Fig. 1. Case 1. Postero-anterior roentgenogram taken following injection of iodized oil into the track.

into the neck. The external jugular vein was doubly ligated and divided to facilitate exposure. The track lay behind the internal jugular vein and just above the bifurcation of the common carotid artery passing between the internal and external carotid arteries. Dissection was carried out along the medial aspect of the internal carotid artery to a point behind the right tonsil. A finger introduced into the mouth identified a finger in the superior portion of the cervical wound, from which it was separated by the superior constrictor pharyngeus muscle and the oral mucous membrane. The tonsil and the posterior tonsillar pillar could be displaced forward by the finger in the cervical wound.

A tonsillectomy was performed by blunt dissection and snare with especial care employed to preserve the tonsillar capsule and the palatoglossus muscle. A curved clamp was then passed into the cervical wound and identified by a finger resting in the tonsillar fossa. The clamp was gently pushed through the superior constrictor pharyngeus muscle. The sinus track was divided in the cervical wound. The lower end of the upper portion was transfixed with a heavy silk suture and drawn into the mouth through the opening in the superior constrictor pharyngeus muscle.

A moderate degree of tension was placed on the transfixed track, and the superior constrictor pharyngeus muscle was split vertically. The track was bluntly dissected upward. When the upper margin of the tonsillar fossa was reached, the lateral pterygoid lamina was identified by palpation. The palatoglossus and palatopharyngeus muscles were divided superiorly to facilitate exposure. The levator veli palatini muscle was split, and the orifice of the eustachian tube was identified by palpation. With strong traction of the track, the dissection was carried up lateral to the nasopharynx. The track ran lateral to and slightly anterior to the mouth of the eustachian tube and passed posteriorly in its upper portion. A finger pressed into the soft tissues in this region could palpate the hard petrous portion of the temporal bone.

Since further dissection could only be carried out blindly with considerable risk, the track was divided and the upper 3½ cm. allowed to drop into the nasopharynx. It was thought that this portion of the track would be contained in the soft tissues behind the nasopharynx with its orifice on the posterior superior portion of the palatoglossus muscle. The track could then drain freely into the nasopharynx.

The incision connecting the oral cavity with the cervical wound through the superior constrictor pharyngeus muscle was closed with interrupted plain catgut sutures. The superficial cervical fascia and the platysma muscle were closed with interrupted chromic catgut sutures and the skin with interrupted fine silk sutures. Penrose drain sheaths were brought out in the mid and lower portions of the wound, respectively, from the upper and lower cervical regions dissected.

The patient's convalescence was without event. The highest temperature attained was 99.2°F. the day of operation. The drains were removed on the second postoperative day and the sutures from the skin on the fourth day, on which date the patient was allowed out of bed.

May 15, 1942, examination showed the tonsillar fossa to be healed and indirect mirror examination of the larynx showed it to be normal. Indirect nasopharyngeal mirror examination demonstrated a small accumulation of granulation tissue on the posterior superior surface of the palatoglossus muscle, presumably the opening of the remaining portion of the

track. A healed scar was seen running up to the orifice of the right eustachian tube. A bougie was readily introduced into the eustachian tube. The cervical wound was nicely healed.

It was believed that the position of the orifice of the track was quite satisfactory since it was well removed from contact with fluid and food during deglutition.

May 20, 1942, a left tonsillectomy was performed with local anesthesia. The soldier was discharged to duty June 5, 1942.

Histological examination of the excised tissue (Fig. 2) demonstrated in sections from the lower portion adjacent to the skin a lumen lined with columnar epithelium. Sections from the mid and superior portions showed a lumen lined by ciliated columnar epithelium with gland-like pouchings. The lumen was filled with inflammatory débris. The surrounding tissue was densely infiltrated with lymphocytes. Further from the lumen hyalinized fibrous tissue surrounded, in turn, by striated muscle was found.

The described case illustrated probably a truly complete branchial sinus. The roentgenographic examination was misleading since it did not delineate the full length of the track. Removal was carried out through a combined cervical and transoral operation including tonsillectomy. Marsupialization of the superior portion of the track was adopted as the most safest method of disposition.

The simple surgical problem of treatment of the cervical auricles is shown by two cases. These congenital lesions should be removed since they are disfiguring and since they may give rise to true neoplasms benign or malignant.

CASE II. I. K., a twenty-three year old white soldier, was admitted April 9, 1942, and discharged after treatment for a gastrointestinal complaint May 12, 1942. During routine physical examination a freely movable mass (Fig. 3) about the size of the tip of a thumb was found at the anterior lower margin of the left sternocleidomastoid muscle. Its consistency was that of twisted cartilage. A diagnosis of branchial cleft developmental abnormality was made. The lesion had been present since birth. The entire mass was readily excised through a transverse incision with local anesthesia.

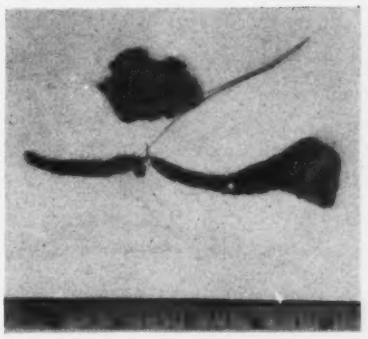

FIG. 2. Case I. Excised sinus track and right tonsil.

FIG. 3. Case II. Photograph of cervical auricle.

On section of the removed tissue a small portion of cartilage was found beneath the skin. Histological examination demonstrated incompletely developed elastic cartilage surrounded by normal skin and subcutaneous tissue.

CASE III. W. C., a twenty-one year old white soldier, was admitted April 11, 1942, and

discharged April 30, 1942, following treatment of a dermatological complaint. During physical examination a small, smooth mass probably containing cartilage was found lying above the right clavicle. It was slightly elevated above the skin level and lay anterior to the right sternocleidomastoid muscle. The swelling, which had been present since birth, was about 2 cm. in diameter. A diagnosis of cervical auricle was made. The mass was readily excised through a transverse incision with local anesthesia.

On section of the excised tissue a small cyst-like space was found lined with dense friable tissue. Histological examination showed small nodules of adult elastic cartilage separated by bands of fibrous tissue.

SUMMARY

A brief review of the developmental background of the lateral cervical sinuses, fistulas, cysts and auricles has been presented. In all likelihood they are of branchial cleft origin. Surgical excision is the recommended treatment as shown in the cases described.

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OSTEOCHONDROFIBROSARCOMA OF THE BREAST*

CASE REPORT

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SARCOMA of the breast of all types represents 0.3 to 9.0 per cent of all malignant tumors, the higher percentages occurring in the figures of the earlier authors. This is explainable on the basis of two factors: First, all cases of cystosarcoma phyllodes were classed as malignant, and secondly, many tumors which were called round cell sarcoma, are now thought to have been anaplastic forms of carcinoma.

Classification of sarcoma of the breast was for many years in a hopelessly muddled state, largely because of the rarity of these tumors. Much of the older literature is worthless, since the only grouping made, was on the basis of cell shape, i.e., "spindle cell," "round cell," and "giant cell" sarcoma.

Fox, in 1934, was one of the first to present a comprehensive classification, based on histogenesis. He divided the connective tissue of the breast into four types: (1) *Intralobular*—giving rise to intracanalicular fibro-adenoma, and cystosarcoma phyllodes, both benign and malignant; (2) *perilobular*—giving rise to pericanalicular fibro-adenoma, and adenofibrosarcoma; (3) *interlobular*, and (4) *interlobar*—both giving rise to pure fibroma, (extremely rare) and true fibrosarcoma.

Thus, it may be said that there are three types of fibrosarcoma arising from the connective tissue of the breast; cystosarcoma and adenofibrosarcoma, in which tumors there occurs an active proliferation of the epithelial as well as the connective tissue elements; and true fibrosarcoma, which contains fibroblasts alone.

Besides fibrosarcoma, a few cases of liposarcoma, neurogenic sarcoma, leiomyosarcoma, rhabdomyosarcoma, etc., are reported. Lymphoblastoma is occasionally seen, usually in conjunction with disease of the lymphatic system elsewhere, since there is normally no lymphoid tissue in the breast. Another rare and interesting tumor, the so-called "carcino-sarcoma," is discussed at greater length below.

CARTILAGE AND BONE IN BREAST TUMORS

Cartilage, osteoid tissue, and bone are reported as occurring in those growths containing active epithelial elements, (e.g., Davidsohn—in cystosarcoma; Miller and McCarty—in adenofibrosarcoma) and in those which do not (e.g., Sailer—in true fibrosarcoma). Thus on a histogenetic basis, these tumors cannot be classified as a distinct subgroup of fibrosarcomas.

The origin of these tissues is a matter of considerable dispute. Various authors maintain that they arise from: (1) Ectopic groups of cells which would normally go into the formation of the thoracic cage; (2) rests of totipotent embryonal cells; (3) metaplasia of fibroblasts.

This resolves itself into an argument as to whether these tissues arise from cell rests, that is, that the characteristics of the tissues formed depend on properties inherent in the chromosomes of the cells which give rise to them, with variation possible on a basis of mutation alone (theories 1 and 2); or whether they arise as the result of the action of local biochemical changes on the primitive fibroblast (theory 3).

The most baffling tumor is the carcinosarcoma, which consists of intimately intermingled areas of carcinoma and sarcoma. Several cases are reported in which cartilage

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and bone have been observed in the sarcomatous areas (Tudhope, Kreibig). Many authors regard these tumors as teratomas, others believe that they arise from the "collision" of separate tumors growing in the same area; while the newer concepts from the experimental school state, that they are formed as the result of a local physiological status which excites both the epithelium and connective tissue to the formation of neoplasms.

FIG. 1. Osteochondrosarcoma of the breast.

FIG. 2. Osteochondrosarcoma of the breast; lateral view.

To support one extreme in the argument, there is the case of McIver, which fulfills the classical description of teratoma, containing cartilage, epithelial cysts, an alveolar process and well formed teeth. Similar cases are reported by Coues, D'Allaines and Hiely, and Gioia and Bianchi.

On the other side, certain workers, transferring carcinoma in the breasts of mice, found sarcoma arising in the concurrently transplanted connective tissue, after several generations, and in several such cases discovered cartilage in the sarcomatous areas (Haagenson, quoted by Stout). The most conclusive evidence for the metaplastic theory is advanced by Dunning, Bullock, and Curtis, who induced carcinoma, carcinosarcoma, and sarcoma, including osteochondrosarcoma, by the subcutaneous injection of 3, 4-benzpyrene into the breasts of rats.

The infrequent incidence of cartilage and bone in the breast may be appreciated by examining the figures collected at some of the larger clinics. In 1915, Geist and Wilensky reviewed the literature as far back as 1858, and collected 435 cases, among which, they found seventeen cases reported to contain one or both of these tissues, roughly 4 per cent. More recent figures are as follows: Bishop, one case in twenty-four; Fox, one in sixty; Miller and McCarty, one in thirty-five; Sailer, two in fourteen; Stout and Hill, three in twenty. A compilation of these series

yields an approximate incidence of 5 per cent.

Articles dealing specifically with this subject are largely isolated case reports. However, in 1937, Raso made an exhaustive search of the literature, and collected seventy-five tumors of all types containing cartilage and bone. Most of these are, from his histological descriptions, fibrosarcomas. Further search in the journals available to us has revealed several more such cases, and we were also fortunate enough to observe one.

CASE REPORT

J. K., a forty-eight year old negress, was admitted to Bellevue Hospital on November 2, 1941. Her complaint was a large swelling of the left breast. She stated that it had started eighteen months previously, and had recently grown very rapidly, with the development of a large, foul-smelling ulcer four weeks before admission. She denied weight loss, weakness and other constitutional symptoms.

Her past history was significant in that she had malaria in 1922, and was suspected of having pulmonary tuberculosis in 1938, which was never proved. There was no venereal history. She was married and separated having had eight normal deliveries. Her menopause occurred four years ago.

Physical examination showed a fairly well developed and nourished negress in good general condition. Detailed examination was essentially negative except for an enormous enlargement of the left breast, with a big, foul-smelling ulcer medial to, and below the nipple. (Fig. 1.) The mass was irregularly nodular in contour, of the consistency of firm sponge rubber, and slightly tender on palpation. A few small lymph nodes were palpable in the left axilla. The right breast was normal.

It was believed that the size of the mass and the ulceration justified a palliative mastectomy which was performed on November 5th. The entire breast and the pectoral portion of the pectoralis major were removed. In the region of the sixth costochondral junction was a small area where the tumor apparently infiltrated the chest wall. The wound was left wide open, the area being partially covered with about twelve Thiersch grafts.

The patient went into shock after the operation but responded to supportive therapy. The grafts took well, and the wound appeared

FIG. 3. Osteochondrosarcoma of the breast. Photograph showing chest wall with Thiersch grafts and beginning recurrence.

in good condition at first, but within three weeks, there was evidence of a local recurrence at the site where the tumor had invaded the chest wall. (Fig. 2.) This mass grew very rapidly, and roentgenograms of the chest showed a considerable spread in the lungs. In spite of an extensive course of radiotherapy, the patient followed a downhill course, and expired on the fifty-second postoperative day. Permission for postmortem examination was refused.

Pathological Description. The specimen (Fig. 3) is a large breast from a colored female, measuring 25 cm. in diameter. Nipple, and skin over most of the mass appear normal, but about 8 cm. medial to the former is a large shallow ulcer 10 cm. in diameter with proud edges. The base is formed by friable yellowish tissue and covered with foul slough. On section, there is a narrow band of connective tissue

just beneath the skin in which a few breast ducts can be made out. Invading this layer and the skin to form the base of the ulcer and mass is formed by a thin layer of fibrous tissue, fat, and the remnants of the pectoralis muscle. At one point, there is a small area where the

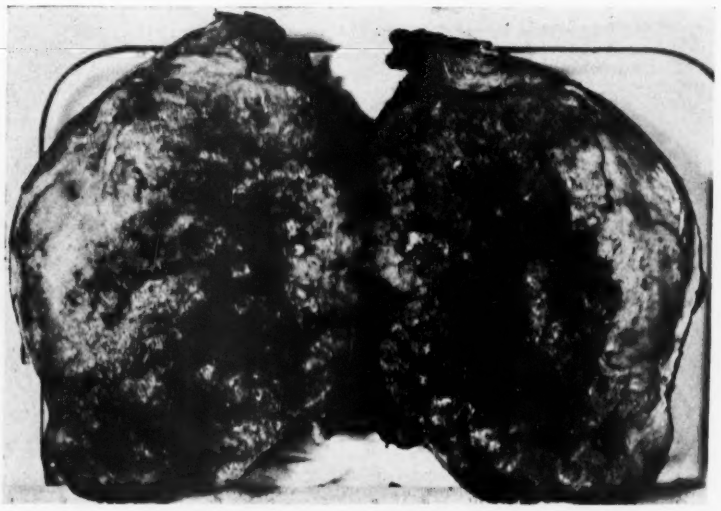

FIG. 4. Photograph showing cross section of the tumor with necrosis of central portion.

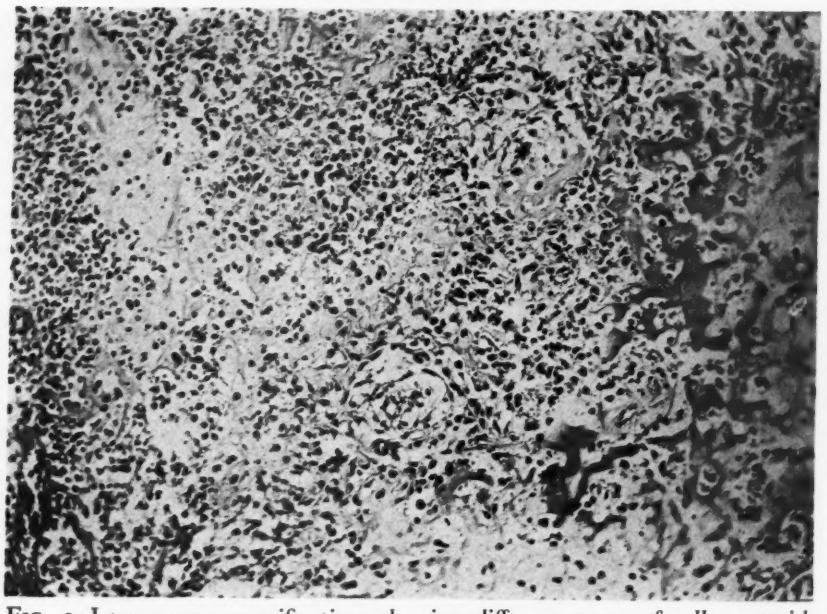

FIG. 5. Low power magnification, showing different types of cells, osteoid deposits, cartilage, etc.

extending down almost to the plane of surgical excision is a mass of smooth, fairly firm, white tissue, which is semitranslucent and resembles fish flesh. Extensive necrosis has occurred in the center of the mass, resulting in the formation of a cavity 10 to 12 cm. in diameter, which communicates by a small sinus with the ulcer on the surface. The walls of the cavity are ragged and friable and it is filled with necrotic and hemorrhagic débris. The under side of the tumor tissue appears to have perforated this layer.

Microscopic examination of sections taken from the surface of the breast reveal stratified squamous epithelium, beneath which is a narrow layer of areolar connective tissue containing a few breast ducts, normal except for compression. Under this layer, and invading it from below, is seen a large mass of abnormal connective tissue cells. For the most part,

TABLE I

Author	No. of Cases	
Anzillotti	1	*Arch. ital. di med. Sper.*, 3: 513, 1938.
Arnold	1	*Virchow's Arch.*, 148: 451, 1897.
Banet, Bolanos and Sutter	1	*Boll. Liga contra el Canc.*, 8: 321, 1932.
Barst	1	*Allg. Path. d. mal. Geschwuelste, Leipsig*, 1924.
Battle	1	*Lancet*, 1: 177, 1901.
Berner	1	*Ztschr. f. Krebsforsch.*, 46: 232, 1937.
Biehl	1	*Beitr. z. klin. Chir.*, 140: 52, 1927.
Billroth	1	Die Krankheit der Weiblichen Brustdruese. Stuttgart, 1886.
Bishop	1	*J. M. A. Georgia*, 30: 232, 1941.
Bowlby	1	*Tr. Path. Soc. London*, 35: 306, 1882.
Busch	1	Chirurgische Beobachtungen, Berlin, 1854.
Busser	1	*Ann. d'anat. path.*, 6: 1247, 1928.
Chevrier and Delval	1	*Bull. et mém. Soc. anat. de Paris*, p. 723, 1910.
Clarke	1	*Tr. Path. Soc. London*, 41: 229, 1889.
Coen	1	*Boll. Sci. Med. Bologna*, series vii, vol. 2 (quoted by Raso).
Cornil	1	Les Tumors du Sein. Paris, 1908.
Cruveilhier	1	*Traite d. anatomie Path., Paris*, 1908.
D'Aunoy and Wright	1	*Ann. Surg.*, 92: 1059, 1930.
Davidsohn	1	*Centralbl. f. Gynäk.*, p. 1357, 1909.
Durham	1	*Brit. M. J.*, 11: 1019, 1883.
Dyke	1	*Brit. J. Surg.*, 14: 323, 1926.
Edelmann	1	*Beitr. z. path. Anat. u.z. allgem. Path.*, 78: 618, 1927.
Fox	1	*Ann. Surg.*, 100: 401, 1934.
Freshman and Kurland	1	*Rocky Mountain M. J.*, 37: 981, 1940.
Fry	1	*J. Path. & Bact.*, 30: 529, 1927.
Goemori	1	*Am. J. Surg.*, 33: 150, 1936.
Happel	1	*Beitr. z. klin. Chir.*, 12: 619, 1894.
Hartmann et al	1	*Bull. Assoc. franç. p. l'etude du cancer*, 22: 378, 1933.
Heurtaux	1	*Bull. Soc. Anat. de Paris*, 1: 15, 1879.
Horner	1	*Beitr. z. klin. Chir.*, 12: 619, 1894.
Hueter and Karrenstein	1	*Virchow's Arch.*, 183: 495, 1906.
Jaki	1	*Deutsche Ztschr. f. Chir.*, 219: 413, 1929.
Kaufmann	3	*Trattato di anat. Path.*, 1930 (quoted by Raso).
Kreibig	1	*Virchow's Arch.*, 256: 649, 1925.
Kreutzfeld	1	Kiel Diss. p. 195, 1931, (quoted by Raso).
Kurosu	1	*Ztschr. f. Krebsforsch.*, 26: 99, 1927.
Lecene	1	*Rev. de chir.*, 33: 434, 1906.
Leriche and Cavaillon	1	Soc. Anatomie, 1908, (quoted by Raso).
Miller and McCarty	1	*Surgery*, 6: 746, 1939.
Morton	1	*Tr. path. Soc. of London*, 4: 127, 1904.
Nadal	1	*Bull. Cancer*, 1910, (quoted by Raso).
Neal	1	*South. M. J.*, 25: 841, 1932.
Orlando	2	L'Ospedale Magiore. Vol. vi, series ii, p. 519, 1913, (Raso).
Raso	1	*Pathologica*, 29: 229, 1937.
Rotolo	1	*Soc. Lombard. di Chir.*, 13: 1935, (quoted by Raso).
Sahrt	1	*Beitr. z. klin. chir.*, 55: p. 574, 1907.
Sailer	2	*Am. J. Cancer*, 31: 183, 1927.
Schreiner and Thibaudeau	1	*Ann. Surg.*, 95: 433, 1932.
Schultz-Brauns	1	*Henke-Lubrasch Handbuch*, 7: 2, 235.
Speer	2	*Frankfurt Ztschr. f. Path.*, 53: 39, 1938.
Stefanini	1	*Gazz. d. osp.*, 71: 564, 1888, (Raso).
Stilling	3	*Deutsche Ztschr. f. Chir.*, 15: 247, 1881.
Stout and Hill	3	*Arch. Surg.*, 44: 723, 1942.
Thinnes	1	*Virchow's Arch.*, 264: 150, 1927.
Tudhope	1	*J. Path. & Bact.*, 48: 499, 1939.
Von Hacker	1	*Arch. f. klin. Chir.*, 48: 93, 1894.
Wagner	1	*Arch. f. Heilkinde*, 2: 275, 1861.
Warren	3	Surg. Abst. on Tumors of the Breast, Boston, 1848.
(The case presented)	1	
Total cases	70	

they are spindle-shaped, with large, oval, vesicular nuclei, and scanty cytoplasm. They are loosely arranged in narrow intersecting bands, throughout which numerous round and polygonal cells of varying size are scattered. Mitotic figures are moderate in number. In many places, are multinucleate giant cells of the foreign body type, which are as numerous in intact areas as in those where necrosis has occurred. In some sections, taken from widely separated parts of the tumor, are small islands of cartilage in the midst of fibroblastic elements, and in others are areas of typical osteoid tissue, merging imperceptibly with the surrounding tumor mass. In some of these small masses of calcium are deposited. Several sections from the deeper portions of the tumor show a number of areas in which the usual cell type has been replaced by closely packed masses of the large round cells. The cytoplasm is basophilic, and the nuclei are large, vesicular and contain one or more hyperchromatic nucleoli. Mitoses are very numerous, and each of the groups appears to surround a central blood vessel. Sections from the wall of the cavity reveal massive hemorrhagic necrosis and an acute inflammatory exudate. In sections taken from the plane of surgical excision, several being taken from the suspicious area described, the tumor tissue is found covered at all points by a narrow layer of fibrous and adipose tissue, with a few widely separated areas of striate muscle. *Diagnosis:* Osteochondrofibrosarcoma of the breast.

REMARKS

This represents a case of fibrosarcoma of the breast without the presence of epithelial elements. Therefore, the tumor probably arose from the interlobular or interlobar connective tissue. This type of fibrosarcoma is suggested in the clinical history by the relatively short duration of the mass in the breast.

TREATMENT

The treatment of these tumors differs in no way from that of ordinary fibrosarcoma. Distant metastases tend to occur late, and axillary lymph nodes, which may be enlarged due to secondary infection, are almost never involved by the tumor. Since local recurrence is frequent, excision of the tumor alone is dangerous.

Most surgeons seem to prefer simple mastectomy with or without removal of the pectoral muscles. Some men, because of the difficulty of a definite preoperative diagnosis, also do an axillary dissection.

CONCLUSIONS

1. Cartilage and bone are seen infrequently in tumors of the breast, occurring in approximately 4 to 5 per cent of breast sarcomas.

2. They are seen in all three subtypes of fibrosarcoma.

3. Except in the few cases which comply in all details with the definition of teratoma, cartilage and bone arise in these tumors by a process of metaplasia.

4. A case of osteochondrofibrosarcoma of the breast is presented.

Table 1 lists alphabetically those authors, who have reported one or more cases of breast tumor, having the histological characteristics of fibrosarcoma, and containing cartilage, bone, or both.

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STRICTURE OF THE RECTUM*

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A PROCEDURE designed to relieve stricture of the rectum, without attack upon the stricture itself, sounds rather contradictory. Yet it may well prove to be the simplest way to relieve the symptoms of this common condition.

A rectal stricture is a narrowing of the lumen, usually within three inches of the anorectal line. It is generally annular or tubular: annular when ring-like, tubular when an inch or more in length. It is hard, inelastic, and in those cases under consideration in this article, the result of an inflammatory process. It involves anywhere from one to all coats of the rectum. Its outstanding symptoms are constipation, tenesmus and mucopurulent discharge. Its usual course is that of endless dispensary treatment, dilatation, chemotherapy, incision, ending often in colostomy. The commonest benign etiological factor is lymphopathia venereum. It can be the result of any extensive mechanical, chemical or bacterial injury to the rectal mucosa.

Dissatisfied with tedious and often futile treatment along accepted lines, it was decided to make a more direct attack upon the problem. This surgery was based upon a new principle, one which apparently has not been considered before.

Careful attention to the patient's own description of the difficulty gives a valuable clue. The history always contains one significant statement: "There was great straining with little result; then the stool finally passed when the straining let up." The stool at this time was liquid or semisolid, not in hard particles; it should have been able to pass through the constricted lumen. Why, then, was there such great difficulty, such marked tenesmus? It is significant that the stool was passed after the straining stopped. The thought immediately arose, that it may not have been the small lumen that resisted the passage of the stool. *It was more likely the prolapse of the rectal wall into the narrow stricture,* plugging it and closing it during the period of straining. Inflamed edematous mucous membrane would be especially susceptible to this action.

In order to relieve this prolapsing into the stiff stricture, a new surgical procedure was evolved to deal with these cases. Up to now, all our efforts had been aimed directly at the stricture. We stretched it, incised it or used diathermy on it, with, of course, only temporary enlargement of the lumen. Contraction occurred again promptly, as it does with all circular constrictions throughout the entire gastrointestinal tract. Our chemotherapy (sulfanilamide, etc.), assisted in reducing the inflammation and subduing the organisms or viruses involved, but it surely did nothing to the firm fibrous tissue already formed. Both cases reported here had received sulfanilamide for long periods without any benefit.

Concluding that the stricture is an unyielding band, it was decided to direct all efforts at the prolapsing rectum above it. Fixation of the rectum at this higher level was decided upon as the remedy.

Procedure. An incision is made in the skin between the rectum and the coccyx. This is deepened, passing through the anococcygeal ligament into the posterior rectal space. The finger is then inserted and it bluntly dissects the rectum from

* From the Kings County Hospital, Surgical Service of Dr. Joseph Tenopyr. Read before the New York Proctological Society, September 29, 1942.

its surrounding structures. It does this posteriorly, then on both sides, and then anteriorly as far as the finger can reach. The outermost aspect of the stricture can

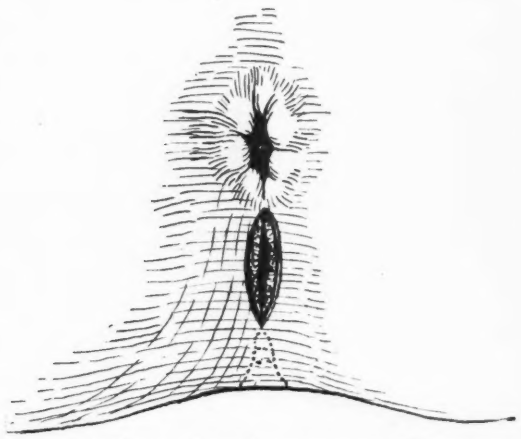

Fig. 1. Incision through anococcygeal ligament.

be palpated, even visualized, and the rectal wall can be freed well above this point. The only upward limitation is that made by the peritoneum. The finger does not readily reach this, and it is not likely to penetrate it even if it does come in contact with it.

Three strips of gauze are inserted, one on each side and one posterior to the rectum. These create local irritations and result in the formation of a broad bed of scar tissue, surrounding the rectum on three sides at least. The rectum practically lies in a trough of scar tissue, and its downward propulsion is prevented. The gauze strips are removed one at a time, each day after the operation. The wound drains pus for three or four weeks, gradually clearing up, and leaving behind it the very desirable bed of scar tissue.

At the time of the operation it is possible to stretch the stricture considerably. It is even possible to incise the outer surface of the stricture, which appears as a white band of fibrous tissue. It is doubtful that this step is advisable, as it has little effect upon the final anatomical result, as subsequent contracture narrows the lumen again. However, this only emphasizes the point of this paper. The small lumen apparently does not produce the symptoms described by the patient. The symptoms are produced by a prolapse above the stricture, which is prevented by this procedure.

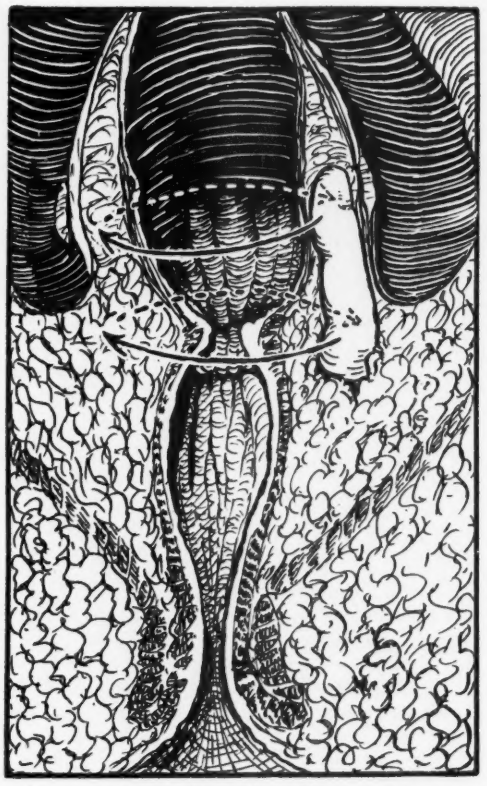

Fig. 2. Finger dissection above stricture.

Postoperative dilatation is not recommended. It apparently adds to local irritation. It is far better to permit the stool, now descending more freely, to dilate the stricture.

The operation was suggested by the procedure devised by Dr. Martin L. Bodkin for prolapse of the rectum in 1912. The first patients on whom this new approach was used were in Kings County Hospital. Both had strictures due to lymphopathia venereum, and had previously received other forms of treatment unsuccessfully.

CASE REPORTS

The first patient, Mrs. R. H. aged forty-two, was admitted October 7, 1941, with a long history of constipation which was gradually becoming worse. She had pain and occasional bleeding as she strained to expel the stool.

She had a positive Frei test and some years ago, had received antiluetic treatment.

The rectum had a tight stricture within easy reach of the index finger. It was about two inches above the internal sphincter, annular, fibrous and unyielding; the lumen was about 3/8 inches in diameter. A small amount of mucous mixed with the stool was swabbed away by means of a cotton applicator. No evidence of malignancy was seen.

On October 13, 1941, the operation was done to relieve this stricture. An incision was made posterior to the anus over the anococcygeal line, two inches in length. The finger was inserted deeply into the posterior rectal space with the aid of some sharp dissection at the level of the anococcygeal ligament. The rectum was then freed mainly by finger dissection, posteriorly and laterally, and as far anteriorly as was possible. Some dense adhesions were encountered and these were severed by sharp dissection. This separation of the rectum from surrounding strictures was carried out well above the stricture itself. The wound was then packed with three long strips of iodoform gauze, one on each side of the rectum, and one posterior to it. The anesthetic was 50 mg. of spinal novocaine.

Postoperatively, the wound drained actively and the iodoform strips were removed at the rate of one per day. Temperature reaction was moderate. On the seventh postoperative day, the stricture was examined and it was found that it could be easily dilated at this stage. It offered so little resistance that the tips of two fingers could be forced into it. (It is to be noted here that this enlarged lumen did not maintain this large caliber; it contracted again partially, but did not again exhibit the symptoms of difficult defecation.)

This patient was followed up in the dispensary after her discharge from the hospital for nine months. She states that she is greatly relieved. She requires mild cathartics, mainly magnesia and oil, but with this routine her bowel movements are satisfactory. They are usually of small caliber, and are produced without straining, pain or bleeding.

Protoscopic examination reveals an interesting condition. When the lumen of the stricture is visualized—(about 1/2 inch in diameter) and the patient is asked to strain, the mucous membrane on the anterior wall prolapses slightly; the other walls show no motion. No "plugging" of the lumen occurs.

The second patient, Mrs. B. H., had a similar history and findings. She, too, had been given sulfanilamide medication at intervals, in years previous to this, without any effect on the course of her condition. She was forty-five years old, had a positive Frei Test and had received diathermy and negative galvanic current for one year, after which she was referred to surgery. At this time, she frequently fainted with the pain and effort connected with defecation. She stated that the effort was usually unproductive and the bowel movements occurred only after she desisted in her efforts. This history so strongly suggested some type of prolapse into the stricture that she was considered a good subject for this type of operative procedure. A small irregularity in the edge of her stricture was first removed for biopsy and was found to be chronic inflammatory tissue. On November 13, 1941, an operation was done similar to that described in the first instance. The thickened fibrous band at the side of the stricture was so clearly visualized from the posterior aspect that its superficial fibers were divided. The rectum was freed on three sides at least, up to a level well above the stricture. Gauze strips were inserted and the usual drainage occurred.

This patient has been observed for nine months. She finds that mild cathartics are sufficient. She no longer has "fainting spells" in connection with efforts at evacuation. The index finger can be inserted through the stricture and the rectal walls palpated beyond this point. The protoscope demonstrated the same interesting condition found in the first case; the anterior wall is the only wall that moves toward the lumen when "bearing down" is attempted. The lumen does not become occluded by its own mucous membrane.

CONCLUSION

This procedure will relieve the symptoms of stricture by the proper fixation of the mucous membrane above the point of narrowing. This can be accomplished quickly and safely by this relatively simple operation.

POSTOPERATIVE TETANUS

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ALTHOUGH postoperative tetanus rarely occurs in the modern hospital, there is the possibility of its development after any operation. The small incidence is due to the effectiveness of modern sterilization. Its repeated occurrence in any institution is *prima facie* evidence of inefficient application of well established principles of prevention. Three cases of fulminating tetanus following hysterectomy in a total of seventy-five laparotomies done by one of us (G. H. B.) within a period of six years in a negro fraternal hospital of sixty beds warrents a study of the etiological factors involved. These are the only cases of postoperative tetanus he has had and they are said to be the only cases that have occurred in the hospital. The 4 per cent incidence in his work in this hospital as compared to the 1.5 to 3 per cent incidence of tetanus developing in wounds received in trench warfare in the first world war before prophylactic inoculation was practiced is significant.[3]

CASE REPORTS (COLUMBIA, S. C.)

CASE I. M. N., a widow, graduate nurse, twenty-three years of age, had the uterus, both adnexa and the appendix removed for bilateral tubo-ovarian abscess of gonorrheal origin on November 5, 1935. The cervix was not removed; the pelvis was drained. On November 10th, her bowels moved, the abdomen was flat and her temperature was 99°F. On November 11th, she complained of soreness of the face, stiffness of the jaws and of inability to open her mouth. There was swelling and tenderness over the parotid gland on one side. She developed general convulsions with opisthotonos; the temperature reaching 103°F. before death on November 13th. Antitoxin was not obtained. She was given morphine for pain and magnesium sulfate intramuscularly to lessen the severity of the seizures. The blood Wassermann was positive.

CASE II. C. H., single, twenty-five years of age, had the uterus, the appendix and both adnexa removed on June 9, 1937, for chronic pelvic inflammatory disease of gonorrheal origin with an adherent, inflammatory left ovarian cyst extending to the umbilicus. The cervix was not removed. The pelvis was drained. Although her temperature never became normal, her abdomen remained flat and her condition was satisfactory so that feeding was begun June 12th. On June 15th, she developed trismus and died June 18th after having repeated general convulsions. Her temperature reached 105.5°F. She was given intravenously a total of 100,000 units of tetanus antitoxin in five 20,000 unit doses. The blood Wassermann was negative.

CASE III. F. B., single, thirty year-old woman had her uterus, appendix and both adnexa removed on July 7, 1941, for bilateral pyosalpinx and intraligamentary uterine fibroid masses filling the pelvis. The cervix was not removed. The pelvis was drained. Her condition remained good and the bowels moved. On July 13th she developed trismus followed by convulsions and opisthotonos. A total of 50,000 units of antitoxin was given intravenously and 60,500 intramuscularly before she died of respiratory failure July 15th. Her temperature reached 106.5°F. The blood Wassermann was four plus.

Comment. Each of these three cases had subtotal supravaginal hysterectomy done for the relief of chronic pelvic disorders. All had pelvic drainage; all did well until the sixth postoperative day when symptoms of tetanus began. Two died in convulsions on the eighth postoperative day and one on the ninth. There was neither history nor evidence of abrasions about the feet or elsewhere. All were operated upon under spinal anesthesia. In all fluid from spinal tap was negative on culture. In two the blood Wassermann was positive and in one negative. Since the last case the surgeon has given every patient operated

upon by him in this hospital prophylactic antitoxin.

Percapita income in South Carolina is low and the hospital, dependent upon the lowest income group for support, has been able to provide only necessities in equipment. After the occurrence of the second case the obsolete sterilizer used in the operating room was replaced by one of standard make. Commercial catgut already sterilized in glass tubes has been used exclusively. Instruments are sterilized by boiling. A local nurse with postgraduate operating room training at Tuskegee Institute had been in charge of the operating room for more than ten years.

Factors in this hospital favoring the development of postoperative tetanus have been: (1) Infection from patients having tetanus on admission. From the habit of going barefooted on the farm the negro gets abrasions which, from barn yard contamination, invite the development of tetanus. (2) Contamination from pigeons which have nested in the attic of the old wooden building. The tetanus organism is a habitant of the lower intestine of many animals and birds. (3) Ineffective sterilization of laparotomy sheets which have been made of heavy unbleached canvas instead of lighter weight cotton sheeting. Bleaching removes natural oils and waxes which make cotton fabric impermeable and resistant to sterilization. Such a sheet, folded, is a compact mass too dense for effective penetration by steam.

CASE IV. B. H., twenty-two years of age, an unmarried graduate nurse, after cystoscopic examination February 27, 1942, had a large soft stone removed from the pelvis of the right kidney by Dr. W. R. Barron. The pelvis was not sutured. The cigarette drain was removed March 8th. On March 16th, she complained of difficulty in opening her mouth. Her temperature was normal. On March 17th, it reached 103°F. and she had a general convulsion. The drainage tract was irrigated with hydrogen peroxide. Symptoms having disappeared after 500,000 units of antitoxin had been given over a period of five days the administration was discontinued. However, rigidity and trismus returned so that before dismissal May 12, 1942, she had received a total of 1,400,000 units. She developed an extreme case of serum sickness which was controlled by histaminase.

Comment. This case of postoperative tetanus developed in a denominational hospital of 100 beds for white patients. The sterilizer is an old model of standard make in which the exhaust had been regulated by steam pressure. It is now regulated by steam temperature at the outlet.

CASE REPORTS (SAVANNAH, GA.)

CASE I. On May 12, 1939, under spinal anesthesia through a midline incision the uterus, the cervix, both tubes, the left ovary and the appendix were removed without drainage from Mrs. O., a white widow, forty-three years of age, because of chronic salpingitis. On May 16th, for the relief of increasing distention from paralytic ileus and septic peritonitis the abdominal wound was opened and the colon was deflated by trocar. A plastic exudate was found over the viscera. The uterine ligament stumps were gangrenous as if from gas bacillus infection. There was foul smelling fluid in the pelvis. Sutures closing the vaginal vault were removed and it was left open for dependent drainage. On May 17th she developed tetanus and died within twenty-four hours in general convulsions. Antitoxin was given intraspinally and intravenously.

CASE II. Mrs. X., thirty-eight years of age, May 12, 1939, through a midline incision had subtotal hysterectomy done for uterine fibroids with removal of both tubes and the appendix by Dr. H. F. The wound was not drained. She developed tetanus on May 17th and died in general convulsions May 18th. She was given 40,000 units of antitoxin intramuscularly and 200,000 intravenously.

Comment. Both patients in Case I and Case II were operated upon in an adjoining room following the amputation of the stump of an infected crushed arm of a man who had been given prophylactic antitoxin on admission the previous week. He died of septicemia without developing tetanus. Both the hysterectomy patients

were operated upon the same day, developed tetanus the same day and died the same day. A child, having an appendectomy done in the same room as the hysterectomies and on the same day had a normal convalescence.

Case III. A white male, thirty-eight years of age, in 1929, had the left thigh amputated by Dr. Rudolph Matas for gangrene developing seventy-two hours after obliterative femoral endoaneurysmorrhaphy had been done. On January 21, 1931, after a similar operation done by one of us (J. Q.) for aneurysm of the proximal portion of the right femoral artery, gangrene developed and the thigh was amputated in the middle third January 28, 1931. General convulsions began February 4th, and he died from tetanus February 5th; 50,000 units of antitoxin were given intramuscularly and 25,000 intravenously.

Comment. This case was done in the same hospital as the hysterectomy cases. In 1938 new operating rooms were built and modern electric sterilizers installed. However, instruments are still sterilized by boiling.

Case IV. In 1936, supravaginal subtotal hysterectomy and appendectomy were done upon a negro woman for uterine fibroids by Dr. Charles Usher. The wound was closed without drainage. The patient developed tetanus on the fifth and died on the eighth postoperative day; 100,000 units of antotoxin were given. The operation was done in a poorly equipped negro hospital without facilities for sterilization.

The eight cases of postoperative tetanus reported by us have occurred in four hospitals in none of which in recent tests by Mood have anaerobic spores survived routine sterilization of goods. Five patients have been operated upon by us and three by other surgeons. Four cases have occurred in Savannah, four in Columbia. Four have been in negroes, four in whites; seven in women, one in a man; none have occurred in children. Seven of the eight patients have died, a mortality rate of 87½ per cent. All of the six patients with hysterectomies have died. All of the cases in women have followed operations upon the genital or the urinary tracts. In every case instruments had been sterilized by boiling.

The comparatively high incidence of the disease after gynecologic operations has been noted in every series of cases. Schmid,[18] in 1937, presented a series which included nine cases of operations on the intestine with nine deaths; twenty-five in gynecologic operations with seventeen deaths and eleven in hernia and hydrocele operations with eight deaths. Poschman,[13] in 1937, notes that Zacherias in 1908 reported 189, Klewart in 1909 reported thirty-three and Peterson in 1910 collected 150 cases, most of which were gynecologic in origin. This with the high incidence of the disease after delivery and after abortion, particularly criminal abortion, suggests that the female genital tract may be the habitat of organisms that have entered from the rectum. However, no tetanus organisms were found in vaginal cultures made for us in 1942 by Mood from 102 white and negro ward patients in Roper Hospital, Charleston, S. C.

Pulvertaft,[10] in 1937, reported a case of tetanus developing after hysterectomy from the use of unsterilized vaginal pads. The recent report of the development of tetanus in experimental animals after the use of sulfanilamide powder in wounds that had been contaminated with the organisms and the citation of a fatal case of tetanus occurring after a pelvic operation in which unsterile sulfapyridine powder had been used in the patient's abdomen has prompted the Food and Drug Administration, after making a study of their bacterial flora, to order sterilization of all sulfa drug powder by the manufacturer at the source.[16]

Matas[14] has attributed two cases of postoperative tetanus that have occurred in his work to infection by organisms already present in the patient's intestine. He advocated catharsis and a diet free from uncooked food for four days before

operation. Wohlgemuth[11] thinks tetanus bacilli that have been harmless intestinal saprophites may be activated to pathogenesis by the trauma of operation. Intestinal infestation varies with environment, farmers and ranchers having a high incidence. Thirty per cent of the people in Peiping, China, were found to have colon infestation,[19] while in Chicago in only one of 100 herniotomy cases were tetanus organisms found.[20] In the first world war the Surgeon General ordered prophylactic antitoxin given before every rectal operation.[17]

We need not apologize that our study has been handicapped by a lack of laboratory facilities. Undoubtedly, the surgical bacteriologist is the greatest need of the hospital of today. In 1938, in answer to a questionnaire, only eight of 137 hospitals in the city of New York claimed to be fully equipped for anaerobic bacteriology and fifteen admitted having no bacteriological laboratories at all.[6] The laboratory should be able to identify the organism in any wound infection and to do special research when required. In 1940, it was recommended by Melaney[5] that the standardization committee of the American College of Surgeons consider the disapproval of hospitals not equipped for adequate surgical bacteriology. Cutler has said, "The explanation of our surgical failures is to be found in the bacteriological and physiological laboratories more frequently than in the anatomical rooms."

We know that the occurrence in the same wound of tetanus bacilli and of anaerobic gas forming organisms is helpful to both and that tetanus is more fatal when occurring with pyogenic bacteria. Conversely, there must be bacteria biologically antagonistic to tetanus. These should be found by experiment and their bacteriophagic action utilized clinically.

The tetanus bacillus, a spore forming obligatory anaerobe, is exceedingly resistant to sterilization. Methods which are effective for pyogenic and vegetative organisms are ineffective for spores. Although the patient's skin at the site of operation can be only cleansed and disinfected, dry goods, gloves, instruments and sutures should have absolute sterilization, the satisfactory accomplishment of which is a technical problem demanding modern equipment and trained personnel.

Packed for ginning by dirty feet into wagons in which stable manure has been hauled for the fertilization of the seed at the time of planting, cotton is infested with tetanus organisms before it reaches the gin. Unaffected by spinning and weaving, living indefinitely in cotton goods, spores find in closed wounds ideal anaerobic conditions for germination, and wool is grossly infested while yet on the sheep.

Although tetanus spores are destroyed in direct contact with steam in ten minutes at 230°F. in four minutes at 240°F. and in one minute at 250°F. to insure sterilization, goods, gloves and instruments should be subjected in the sterilizer for thirty minutes to steam under fifteen pounds pressure at 250°F.[8] Only that higher temperatures may be reached is steam used under pressure. In the sterilizer steam temperature in the heart of the load must equal that applied to the load. Steam penetration lag may be thirty minutes and in obsolete types of sterilizer temperature in the center of packages of goods may never be raised to the boiling point of water. The modern pressure sterilizer is operated in terms of temperature of steam applied to the load which is measured at the coolest place in the sterilizer—the discharge outlet. This is placed at the bottom to permit the escape by gravity of air which, being heavier than steam, settles. When the thermometer in the outlet registers 250°F. the escape valve closes, for at this temperature all untrapped air has escaped. Air and steam do not mix and there can be no bactericidal action of steam on goods in pockets of residual air.

The sterilizer should not be overloaded. With goods loosely packed to facilitate penetration by steam vertical airways should be left between packs. Instruments

should be free from scale, mechanically clean and with locks open so that all surfaces have contact with steam. Walter[1] has perfected a sterilizer for instruments in which steam reaches 273°F. in twenty seconds. All spores are killed in two minutes. Although effective against pyogenic and vegetative bacteria, boiling does not insure the death of tetanus spores.[1] Yet in most hospitals in this section boiling is the only method of sterilization used for instruments.

Every case of tetanus should be a challenge in the prevention of the spread of the infection. Gloves, dressings, instruments, everything coming in contact with the wound should be sterilized or burned. Care should be taken that wound discharge does not escape upon the bedding. If a drop reaches the floor, it should be left covered with chlorinated lime for a day. When the case has terminated the mattress and bedding should be sterilized. If no autoclave is available, they should be burned; for tetanus spores, dormant for years, become active in favorable environment.

Postoperative tetanus has its greatest incidence and its greatest mortality in the newborn. Before asepsis was practiced, in some of the West Indian Islands more than half of the infant mortality among negroes was from tetanus neonatorum, "The eight day sickness."[6] Jewish infants have an additional incidence from circumcision. The incidence of tetanus that develops in the modern hospital after major operations is unknown. Because of the approbrium most cases are not reported. Neither the State Board of Health nor the Duke Foundation has any data on the incidence of postoperative tetanus in South Carolina. All cases of tetanus are listed together and no hospital has specific data on the subject. Undoubtedly, there is a small but a definite incidence generally over the nation. Light or atypical cases may not be recognized and others are recorded without mention of tetanus as a complication. Facts, even about known cases, are hard to obtain. Hospitals are reluctant to give out information about them because of the threat of law suits.

Unsterile catgut has been blamed for the development of tetanus after operation. Although infested in the living state with spores, sheep intestine, after having been made into catgut, is repeatedly heated by reliable manufacturers to 270°F. which insures its absolute sterility. If the infecting organisms were from the patient's own intestine, tetanus would in every hospital be a common postoperative complication of appendectomy; for the application of phenol and of alcohol to the appendix stump before invagination does not kill tetanus spores and if perforation occurs there is peritoneal soiling from intestinal contents. The minimum period of incubation, the extreme virulence of the organism, the rapidly fatal course of the disease indicate in seven of the eight cases reported by us the overwhelming infection occurring at the time of operation.

CONCLUSIONS

We have reported eight cases of postoperative tetanus which we attribute to the use of unsterile goods or instruments at operation. Although the condition is more common in hospitals having substandard equipment, it also occurs in those having the best. This results from inability to sterilize the skin through which the incision is made and from the fallibility in the operation of the sterilizer. Color change from heat in commercial sterilizer controls is unreliable in that it does not prove contact with steam. The sterilizer should be inspected regularly for mechanical defect and goods should have monthly bacteriologic tests with spore-forming anaerobes. The services of a competent bacteriologist should be available to every hospital. If sterilization of goods and of instruments cannot be relied upon, prophylactic antitoxin should be given after every operation. Instruments should be sterilized by steam under pressure and not by boiling. Without wound suppuration and without peritonitis the laparotomy patient may

die from infection by anaerobic spores, a tragedy which absolute sterilization would prevent in most cases.

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BACILLUS WELCHII INFECTION OF THE PROSTATE AND ITS TREATMENT*

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A REVIEW of the literature over a forty-six year period fails to reveal a single case of incidental finding of the Bacillus aerogenes capsulatus in the prostate gland.

It is of interest that Welch and Flexner in their original work, when they reported the gas forming organism, included three cases involving "inflamed parts of the urinary tract." All three were postmortem discoveries. Two of the cases were from Dr. Halstead's service: the first following retention of urine due to urethral stricture; the second following retention and hypertrophied prostate. At autopsy the Bacillus aerogenes capsulatus was recovered from the renal pelves, ureters and bladder. The third case was from the service of Dr. Williams, of Buffalo, and Welch and Flexner reported the presence of Bacillus welchii in the calices of both kidneys.

Welch, in his Shattuck lecture of 1900, reported the finding of Bacillus welchii in inflammation of the bladder and renal pelvis without the detection of gas. Since then little has appeared concerning urinary tract infections.

Thirty-two years elapsed before Ferrier and Bliss reported a case in which the Bacillus welchii was cultured from the center of a renal stone, where it remained dormant until a pyelolithotomy caused release of the organism and enabled it to resume its gas-producing capacity.

In 1934, Goldstein and Abeshouse reported the finding of Bacillus welchii in the prostate following perineal prostatectomy. They conclude, however, that the source of the infection may have been a contamination from the rectum.

Mencher and Leiter (1938) report a number of Bacillus welchii infections of the urinary tract. Following up the work of Ferrier and Bliss they were able to isolate the Bacillus welchii in the calculi of three different patients. They likewise report the discovery of this bacillus following one first-stage prostatectomy and one second-stage prostatectomy. Both cases were fatal.

It will be noted that in all of the above mentioned cases this organism was demonstrated following some operative procedure. Some of those reporting concede the possibility of contamination and others make the interesting comment that anaerobic infections may follow operations on the urinary tract due to the incidental presence of these organisms in the urinary organs. This latter idea was first expressed by Welch in 1900. Franck demonstrated in some cases that the lymph channels of the right kidney capsule may be "ultimately related to the appendix and cecum." Stahr by injection studies demonstrated the close connection of the lymphatics of the kidney capsule with the cortex and pelvis. Hutchinson is of the opinion that bacteria may pass from the bowel to the kidney by way of the lymphatics.

Moench, Torry, Reed and Orr have all made the interesting observation that Bacillus welchii is found in large numbers in the large intestine of normal patients. Before the above mentioned observers found the organisms in normal patients, the arerogenes capsulatus had been found as a normal inhabitant in the stomach in cases of achlorohydria and in cases of carcinoma and pernicious anemia.

* From the Department of Urology, Gouverneur Hospital, Dr. Joseph A. Hyams, Late Director. Read at a meeting of the West Side Clinical Society, New York, New York, May 8, 1943.

Schottmüller, Falls, and Bysshe report the gas bacillus with rather surprising frequency in the normal vagina. Curtis, on the contrary, believes that it is only rarely present. In the reported cases about one-third of them were primiparas. This would tend to refute the theory of Stander and Falls that women with relaxed perineal outlets are more likely to have Bacillus welchii.

The incidental finding of this bacterium in the urine has been reported by Weiser; Bennett, Albarran and Cottet; Runeberg; and Moencher and Leiter.

The incidental finding of this organism from the prostatic fluid, so far as the writer can determine, has never before been reported.

CASE REPORT

A sixty-four-year old Hebrew laborer was admitted to Gouverneur Hospital complaining of frequency and nocturia. One year before he had remained under treatment for six weeks at Gouverneur Hospital for nephritis.

His complaints on admission were (1) nausea and vomiting, (2) dryness of the mouth and lips; (3) spells of dizziness; (4) frequent episodes of nocturia; (5) rectal pain; (6) loss of 14 to 15 pounds of weight over a period of one year.

At the age of twenty he had gonorrhea, and chancre without rash at the age of thirty. His luetic condition was treated with intravenous therapy. His hypertension was discovered eight years before. He had suffered from dysuria and nocturia (three to four times) for three years. In spite of his original history of nephritis there was no history of puffiness of lids or leg edema. There was no history of severe childhood disease. Three years before he had one episode of urinary retention with slight hematuria which was relieved by catheter.

The patient's temperature on admission was 101.6°F.; pulse 88; respirations 22. He looked acutely ill and toxic.

The positive physical findings were 3 ounces of residual urine; blood pressure 190/90; hypertensive fundi, with retenitis but no disc change. There was slight edema of the disc. Rectal examination revealed a moderately enlarged prostate, benign in consistency. There was no bogginess over the entire area of the prostate. There were no external or internal hemorrhoids or fistulas. The anal sphincter was of normal tone.

Laboratory findings were as follows: *Urine:* albumin 3 with a few scattered red blood cells; white blood cells, 10 to 12 per high power field. *Blood:* hemoglobin 50 per cent; red blood cells 2,700,000; white blood cells 6,000; polymorphonucleous 75 per cent; lymphocytes 25 per cent; no irregular forms; sedimentation rate 42/100 mm. per hr.; nonprotein nitrogen 62 mg. per cent; creatinin 1.7 per cent; uric acid 3.8 per cent; carbon dioxide combining power 50 vol. per cent; sugar 98 per cent; cholesterol 270; cholesterol esters 125; blood chlorides 540.

A urological consultation was requested, and it was suggested that the cystoscopic examination should be repeated, in view of the previous cystoscopic findings of intra-urethral prostatic encroachment. The chief complaints at this time were nocturia, dysuria, and perineal pain with radiation to the tip of the penis. Residual urine was 3 ounces. The prostate rectally was moderately enlarged, benign and boggy over its entire area. It did not appear fixed. Prostatic massage and smear and culture of the expressed fluid was advised.

The report of the prostatic fluids and their time intervals follows:

Date	Smear	Culture
6/9/42	Bacillus welchii	Bacillus welchii
6/11/42	Bacillus welchii	Bacillus welchii
6/26/42	Bacillus welchii	Bacillus welchii
6/30/42	Bacillus welchii	Bacillus welchii
7/2/42	Bacillus welchii	Bacillus welchii
7/7/42	Bacillus welchii	Bacillus welchii
7/14/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii
7/18/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii
7/22/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii
7/27/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii
8/3/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii
10/42	Neg. for Bacillus welchii	Neg. for Bacillus welchii

Treatment consisted of combined polyvalent Bacillus welchii antitoxin serum 1 vial twice each day for ten days. During this period 40 gr. of sulfathiazole were given daily for eight days. The latter was administered with caution because of the patient's secondary

anemia and poor kidney function. The sulfonamide blood level remained, surprisingly enough, at 8.9 mg. per cent during the entire course of treatment.

The patient stated that his perineal pain and discomfort in the prostatic area had subsided following the ten-day treatment. The residual urine, however, remained at three ounces and he still complained of diminished urinary stream and nocturia.

Following the third successive negative prostatic culture the patient was cystoscoped under local anesthesia. A No. 24 pan-endoscope was passed through a tight meatus. The bladder was tolerant and its capacity good. The media was clear. The entire bladder mucosa was somewhat congested. Both ureters were visualized and were seen to be exuding clear urine. There was considerable middle lobe enlargement and moderate bilateral lobe encroachment.

A transurethral resection was done under 60 mg. of spinal procaine. A No. 24 McCarthy resectoscope was introduced into the bladder without difficulty. The median lobe and the intruding portions of the lateral lobes of the prostate were resected. All bleeding was controlled with the coagulating current. A No. 24 whistle tip catheter was introduced into the bladder for constant bladder drainage. The patient withstood the procedure well and returned to his bed in good condition. The pathological report of the tissue sent to the laboratory was fibro-muscular hypertrophy of the prostate.

On the second postoperative day the temperature rose to 101°F. The patient was given an infusion of 10 per cent glucose. The bladder return was clear. On his fifth postoperative day the nonprotein nitrogen rose to 125 mg. per cent. He was given a number of infusions. Six days following operation the temperature was normal and the urethral catheter was removed. The patient voided per urethrum without difficulty. His residual urine was 45 cc. Eight days following operation the residual urine was 0. The patient was discharged on the twelfth postoperative day.

The patient was seen three months following his discharge. The voided urine was slightly cloudy. The albumin remained 3 plus. There were scattered pus cells in the centrifuged specimen. Residual urine was 0; nocturia 1 x. He had no difficulty in voiding, and there was no return of his original perineal pain. The prostatic fluid on smear and culture was negative for Bacillus welchii.

REMARKS

The Bacillus welchii, more commonly known as Bacillus aerogenes capsulatus or gas-forming bacillus, is a short, rather broad, non-motile, Gram-positive rod. It grows easily under strict anaerobic conditions. In the animal body it forms capsules and sporulates. A number of culture media have been devised, the most common one known as the stormy fermentation of milk and the characteristic formation of clot, acid and gas. The aerogenes capsulatus is classified into types A, B, C, and D. Only Type A is found in the human body. The two toxins produced by the organisms are known as hematoxin and myotoxin, and these are responsible for the characteristic clinical observations.

The Bacillus welchii can apparently inhabit the prostate gland without gas formation and without exhibiting any clear-cut symptomatology. It seems reasonable to assume that if prostatic cultures were more routinely done and more often grown under anaerobic conditions, the aerogenes capsulatus would be demonstrated more frequently. The organism undoubtedly does play a rôle in some chronic urinary infections and to these may be added the chronic infection of the prostate.

The blood picture which this case presents sharply parallels the findings of Cornell, Herter, Reed, Torry and others. They have all shown that in rabbits suffering from chronic Bacillus welchii infection without gas formation, there is first, a considerable fall in the hemoglobin determination and that this remains low throughout the infection. The color index shows irregular variations. There is a marked depression in the erythrocyte count. There is little known about the leucocytic picture in chronic Bacillus welchii infection, and it is difficult to draw any parallel from the work of animal experimentation since the animals were inoculated intrasplenically.

We should expect in animals that with such a manipulation the leucocytes would show an initial fall, followed by a marked rise.

Long and Bliss (1937) reported the first experimental results of sulfanilamide therapy in Clostridium welchii infections. This work was closely followed by Domagk (1937), who found that uleron was effective on the Fraenkel strain of gas gangrene experimentally. Bohlman (1937) treated three patients with gas gangrene with sulfanilamide following crushing injuries. All three patients had received prophylactic doses of combined gangrene antitoxin which failed to prevent the development of the disease. The cases responded rapidly to sulfonamide therapy. In 1938, Kennedy confirmed these results.

Stephensen and Ross (1940) found that sulfanilamide and sulfapyridine protected mice against small lethal doses of Clostridium welchii, Type A, when injected intraperitoneally. This treatment, however, was found more effective against large lethal doses when combined with serum treatment.

SUMMARY

1. A case of preoperative Bacillus welchii prostatitis without gas formation is reported and its eventual course and cure described. This, so far as I am able to determine, is the first such case to be added to the literature.

2. It is suggested that in cases of chronic Bacillus welchii infection, the blood picture of Cornell and others found in animals is also found in man suffering from a like infection.

3. It is probable that sulfonamide therapy acts as it does in other infections to cut down the rate of multiplication of the bacteria to such a degree that the organisms cannot produce enough toxin to inhibit rapid phagocytosis. This gives the phagocytes an opportunity to rid the tissues of the organisms and with the combined effect of antitoxin serum, recovery from the infection results.

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HYPERTHYROIDISM OF THE JUVENILE FAMILIAL TYPE*

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DURING the past two years our interest in the problem of the juvenile hyperthyroid patient, particularly of the familial type, has been stimulated by observation of two patients in our hospital. The familial aspects and the allied endocrine dysfunctions have been of particular interest. Although these cases may no longer be considered rare, they are of such relative infrequent occurrence as to merit presentation.

A recent excellent comprehensive survey of this subject has been furnished by Moolten and Bruger[1] which makes further summary redundant. We will, therefore, limit our discussion to the salient features as illustrated by our two patients.

CASE REPORTS

CASE I. M. M. Chart No. 129171. The patient, age seven years, was first admitted on the pediatric service January 31, 1941, at which time there was a history of extreme nervousness, increasing prominence of the eyes, recent weight loss and excessive appetite for the past five years. Both parents were living and well. One sister (N. M.) age thirteen, was a diabetic of five years' duration; (I. M.) age eleven, had rheumatic heart disease; (R. M.) age ten had been previously hospitalized for a symptom-free benign goiter not operated upon; A. M. (Case II) age six, had a subtotal thyroidectomy for diffuse hyperthyroidism.

Physical examination revealed a seven-year old white female, well developed but apparently underweight. Marked emotional instability was obvious. There was definite exophthalmos —equal bilaterally, lid-lag and lack of convergence. The pupils were equal and reacted normally to light and accommodation. The tonsils were slightly hypertrophied and the anterior cervical lymph nodes were moderately enlarged. The thyroid was diffusely enlarged, soft and nodular on palpation, and a marked bruit was present. The heart rate was 136, sounds intense; murmurs absent; respiration 24. Rectal temperature was normal. Breasts were undeveloped and signs of beginning puberty were absent. A fine tremor of the extended hands was noted. At the time of this first admission the pediatric service decided to continue medical therapy which consisted of absolute bed rest, sedation, and high caloric diet. On March 1, 1941, Lugol's solution (m 2 T.I.D.) was instituted, and later increased to (m 5 T.I.D.). This resulted in a slight lowering of the pulse rate. Surgical consultation a month later noted no improvement. The pulse rate was still elevated (150), and the thyroid gland had increased in size. On April 7th, the basal metabolic rate was plus 7. Lugol's solution was discontinued on April 10th. The pulse rate one week later had increased to 170 but dropped to 130 after the patient was placed on bed rest. At this time Lugol's solution (m 2 T.I.D.) was again started and one week later was increased to m 5 T.I.D. Thyroid extract gr. ½ was given daily until June 9, 1941. During this period the basal metabolic rate dropped to minus 18 and it was noted that the thyroid gland had almost doubled in size and was symmetrical. The patient's weight increased from 43¼ pounds on admission to 63 pounds on discharge July 3, 1941, and was apparently in good condition.

On readmission, October 17, 1941, she presented the following symptoms of hyperthyroidism: Exophthalmos with confirmatory

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eye signs, soft diffuse thyroid enlargement, pulse 132 at rest, accentuated heart sounds, blood pressure 145/65, marked tremor of fingers and tongue, and weight 51¾ pounds. Following consultation she was accepted for thyroidectomy and transferred to the surgical service on November 4, 1941. Preoperative preparation consisted of bed rest, high caloric diet, phenobarbital, Lugol's solution (m 10 T.I.D.), vitamin B complex and increased protein intake orally. The basal metabolic rate on November 11th was plus 15. Despite continued therapy the pulse rate remained relatively high (110–130). However, the patient's weight increased five pounds. On December 1st there was definite signs of improvement. The emotionable stability was better and the pulse rate more stable. Although the maximum pulse rate was 130, a tendency toward a slower rate was apparent and she continued to gain weight. The pulse pressure showed no tendency to increase, and iodinization had been adequate. By December 3rd the basal metabolic rate had dropped to plus 9. Cardiac consultation at this time showed evidence of marked toxicity but this was thought not to contraindicate surgery. (Fig. 1.) On the following day, cyclopropane-oxygen anesthesia was administered by way of an intratracheal catheter and a routine collar-type incision was employed through which both superior poles were ligated with silk. This type of incision was decided upon since it was believed that it would offer a more rapid and thorough means of approach to the problem of ligating the poles in this highly toxic patient. The total elapsed operating time of eleven minutes apparently justified the decision to employ this means of approach.

Fig. 1. Case 1. Preoperative appearance.

Fig. 2. Case 1. Postoperative appearance.

On return from the operating room the pulse rate was 140–170, of good quality and regular. The child reacted from anesthesia and became restless, which was controlled by paraldehyde given per rectum. The oxygen mask was well tolerated and although the respirations were shallow and thoracic in type there was no evidence of respiratory obstruction or anoxia. Ergotamine ½ cc. was given at 4-hour intervals with Lugol's solution m 15. However, the pulse rate, temperature and respiration continued elevated. The child was motionless, failed to respond to stimuli and the corneal reflexes were absent. A venoclysis of 1,000 cc. of 10 per cent dextrose in saline and 10 cc. of 10 per cent sodium iodide was given. The respirations improved and

the temperature was controlled with ice packs.

On the following morning the patient was given 1,000 cc of 10 per cent dextrose in normal saline and 10 cc. of 10 per cent sodium iodide. Her condition remained unchanged except that she now reacted to stimuli. In the evening a continuation of the present régime resulted in a lightening of the coma although the pulse remained very rapid. The patient was placed in an oxygen tent. On December 6th the patient was much improved, fully conscious, took fluids well by mouth, sat up in bed and ate ice cream and lolly-pops. The pulse rate decreased to 130. Marked improvement continued; she took a soft diet, candy, and fluids; the pulse was steadier and slower. The drain was withdrawn and alternate skin clips removed; the incision was healing well. On December 9th all clips were removed; the wound was healing well, and the patient's general condition was excellent. On December 13th the basal metabolic rate was minus 9. Pulse rate varied between 100 and 130 and the patient's condition was satisfactory for further surgery to be limited to hemithyroidectomy.

Two days later a right hemithyroidectomy was performed. Microscopic examination of tissue showed marked connective tissue proliferation and numerous focal areas of round cell infiltration. Some of the acini presented low papillary projections. The pathological diagnosis was toxic goiter.

The patient's convalescence following this operation was uneventful. Her pulse rate never exceeded 140. The maximum temperature was 102°F. on the first postoperative day. On the following day the pulse was 120 and the temperature 100°F. A striking point was the improvement in the patient's former surly disposition. Her appearance became much less apprehensive. She was apparently happy and had gained seven pounds. This represented a 20 per cent gain in total body weight since her admission to the surgical service, and a net gain of about 12 per cent since her operation three weeks before. The wound healed well except for a small granulating area in the center. Application of a 10 per cent solution of silver nitrate removed the exuberant tissue.

On January 19, 1942, a small fluctuant mass about 2 cm. in diameter was noted to the right of the midline. This was assumed to be a sterile abscess due to silk suture irritation. Incision and drainage was performed and a culture taken which proved negative for micro-organisms. Drainage subsided following the application of sulfathiazole powder. The patient was discharged on February 25th. Further observation of the patient was continued in the out-patient department.

On April 14th, she was re-admitted exhibiting little evidence of thyrotoxicosis and in good general health. There was only slight tremor, pulse 106, no apparent improvement in the exophthalmos, marked lid-lag, freely moveable scar and several areas of keloid-like scarring. The left thyroid lobe was barely palpable.

A tender fluctuant area about 1 cm. in diameter was noted at the site of the original sterile abscess and on April 23rd this mass was opened under local anesthesia. About 5 cc. of purulent fluid was evacuated along with two pieces of black silk suture material. Despite this procedure the wound continued to drain and two additional pieces of black silk suture were removed on April 29th.

On May 11th, sinus tract drainage continued and a small amount of seropurulent and granulation tissue was removed. On May 14th, débridement, drainage and curetting of the sinus tract was performed under general anesthesia. Despite these operative procedures a persistent sinus reformed with continued seropurulent discharge and exuberant granulations. The sinus was probed and found to extend toward the right superior thyroid pole. Additional black silk suture material was removed.

The patient was discharged to the clinic June 11th with a persistent silk sinus. (Fig. 2.) Her weight on admission was 64½ pounds; blood pressure 96/70. Her weight on discharge was 68½ pounds; blood pressure 105/78. A slight but steady weight gain was noted, and the blood pressure showed little variation.

Continued observation of this patient is being carried out in the endocrine clinic. She has also been examined on repeated occasions at the thyroid committee conference. Despite the complete subsidence of thyrotoxic symptoms, it was the concensus of opinion that further surgery will be necessary because of the probable danger of reactivation of the remaining intact lobe. However, in view of the considerable recent operative trauma, it was decided that further intervention should be

deferred and that conservative measures be continued especially since the patient and family are co-operative and continued observation will be possible.

Fig. 3. Case II. Three sisters, ages five and one-half years, seven and one-half years and thirteen and one-half years, respectively.

Five months following operation this patient without further surgery can be considered a normal child. She shows a significant improvement in behavior, has lost her former surly attitude, weighs 74 pounds and presents a marked recession of her original exophthalmos. Basal metabolism at this time is minus 17.

Case II. A. M. Chart No. 112958. The patient, age six years, was admitted on May 8, 1942, with complaints of tremor, increased excitability, bulging of the eyes, intolerance to heat, and swelling of the neck. She was first admitted October 17, 1941, for a swelling of the neck which was present for three weeks. On this admission there was no evidence of exophthalmos or other symptoms of thyrotoxicosis. There was a diffuse hyperplasia of the thyroid, the heart was not hyperactive, basal metabolism 0, electrocardiogram showed sinus tachycardia; blood chemistry was normal. After two weeks' observation the child was discharged and referred to the endocrine clinic for follow-up. While under observation during the six months prior to the present admission there had been a gradual development of toxic signs which became progressively worse, and hospitalization for surgical removal of the thyroid was advised. (Fig. 3.)

The patient was thin, pale, very active and an extremely co-operative female. No abnormalities of the head were noted; pupils were equal and reacted to light and accommodation. There was slight internal deviation of the left eye (Fig. 4); palpebral fissures were widened; marked exophthalmos; lid-lag definite; no wrinkling of the forehead. Ears and nose were normal. The thyroid was enlarged bilaterally (Fig. 5), the right lobe was larger than the left; the isthmus was readily outlined. A thrill was palpable and a bruit was audible over the thyroid. Lung expansion was equal and resonant to percussion; there was vesicular

breathing; the heart rate was 158; blood pressure 150/50; the apex was in the sixth intercostal space in the midclavicular line. Cardiac consultation revealed heart sounds was there any respiratory difficulty. The oxygen mask was well tolerated. She reacted from anesthesia in normal time and was able to phonate without difficulty. Her temperature

FIG. 4. Case II. Preoperative appearance.

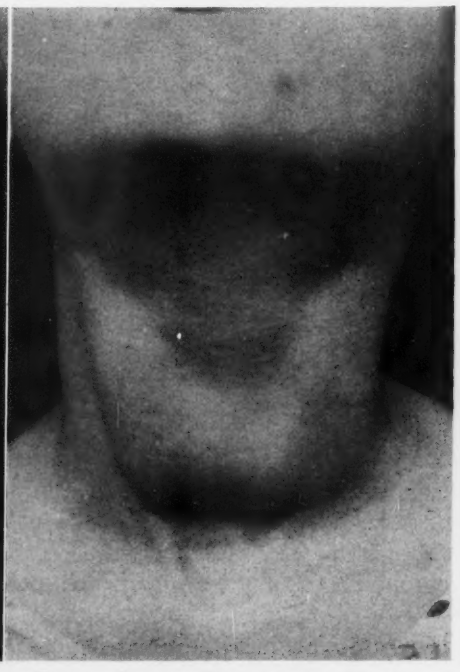

FIG. 5. Case II. Preoperative appearance.

hyperactive; no murmurs were present. The abdomen was soft and symmetrical. Liver and spleen were not palpable. Tremors of the hands were present and all reflexes hyperactive.

Following admission, the patient was examined in endocrine and pediatric consultation. The thyroid was diffusely enlarged with irregular nodules throughout. On a four plus scale, the thyroid was enlarged to two or three plus. It was concluded that the child had diffuse thyrotoxicosis with superimposed toxic adenoma. Surgery was recommended and routine preoperative preparation was instituted. Under this régime the pulse rate ranged between 120 and 140, whereas on admission the pulse rate was over 140. Basal metabolism fell from plus 28, to plus 4; the patient gained weight, the tremor was less pronounced and the general condition improved markedly.

May 28th, after two weeks of preparation, subtotal thyroidectomy was performed through a collar incision. Approximately $\frac{7}{8}$ of the left lobe, $\frac{3}{4}$ of the right lobe and the entire isthmus were removed.

The child was observed every hour during the day following operation and at no time rose to 103°F., but was readily controlled by alcohol sponge baths. The pulse was maintained at about 116 and respiration 30. On the second postoperative day the temperature was 99.4°F., pulse 140, and respirations 40. On the third postoperative day the temperature rose to 104.4°F. and remained elevated in spite of repeated sponge baths. Postoperative atelectasis or pneumonia of the left base was suspected by the pediatric consultant. *X*-ray examination did not confirm this opinion. Ice bags were placed on the extremities and head. There was no evidence of respiratory difficulty. The patient continued to receive 90 per cent oxygen by mask. She was able to take small amounts of fluid by mouth, including Lugol's solution. Ergotomine $\frac{1}{2}$ cc. was administered every three hours. The dressing was removed and the wound inspected. Oxygen inhalations were continued. The child continued to become more alert and the pulse was of better quality and slower. Fluids were well taken. Dressings were changed and the drain removed; the wound was clean.

The further postoperative course was entirely satisfactory. It was the opinion of the

endocrine consultant that the patient had suffered a mild postoperative thyroid crisis which apparently was attributable to anoxemia. The surgical service did not completely concur in this opinion. Although conceding that there may have been a mild hyperthyroid crisis, this certainly was not attributable to an anoxemia since at no time had there been any respiratory difficulty and the patient had been continuously receiving 90 per cent oxygen by mask.

The further postoperative course was entirely uneventful; the maximum pulse was 132 with an average pulse of 110 to 120; the temperature was below 100°F., blood pressure 116/58. The wound healed by primary union and the patient was out of bed on the fourth postoperative day and was ambulatory on the fifth day. On the sixth postoperative day the basal metabolism was minus 4. She was discharged on the fourteenth postoperative day and was referred to the endocrine clinic for follow-up. The pathological report was as follows: Proliferation of acini filled with degenerated colloid. Some of the acini show low papillary projection. The connective tissue is increased in amount and there are many areas of small round cell infiltration. *Diagnosis:* Toxic adenoma of the thyroid.

The patient has been closely observed for the past five months. She has gained weight, her pulse averages 80 to 84 and her basal metabolism at present is minus 4. She has shown no tendency toward recurrence of her former toxic state.

REMARKS

The familial aspect of juvenile hyperthyroidism is illustrated by our two cases, which included four members of one family, three sisters and one cousin. Three members presented symptoms of hyperthyroidism and one of benign goiter. Of additional interest is the presence of diabetes mellitus in another sister and also the tendency toward the diabetic state was noted in Case II. This endocrine relationship has been demonstrated by Steener and Newcomb.[2] The sugar tolerance curve (in mg. per cent, fasting 85, ½ hour 145, 1 hour 160, 1½ hours 170, 2 hours 110) in Case II does not appear typical of the thyroid type but is prolonged, apparently tending toward the diabetic variety although the fasting blood sugars are low.

Case I presented the history of exophthalmos at the age of two years. According to the literature, this is a rare finding. Elliott[3] reported the presence of exophthalmic goiter in his case before one year of age as being "a real medical rarity."

We are in accord with the concensus of opinion that the juvenile hyperthyroid case is a definite surgical problem for which prolonged medical therapy should not be undertaken. This is borne out in our experience with the management of our two patients.

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APPENDICULOCOLIC FISTULA

CASE REPORT

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EXPLORATORY operation was performed in the following case because of recurrent, indefinite abdominal pain, and unusual roentgen findings.

FIG. 1. Appearance after barium meal.

C. H., a private soldier, colored, aged twenty-four, had been seen at sick call several times because of abdominal cramps. No positive physical findings were ever noted. He was admitted to the Station Hospital, November 14, 1942, complaining of steady soreness in the right lower quadrant of his abdomen for the past two days, aggravated by stooping, lifting or straining. From November 8th to 12th he had had frequent periods of crampy pain in the right side and peri-umbilical region. He had had similar but less prolonged attacks of cramps, most often occurring at night, ever since he could remember, never with nausea, vomiting or diarrhea. Severe attacks had been accompanied by mild anorexia. He remembered vaguely a "long" abdominal illness at about ten years of age.

His past history was negative except for the usual exanthemas and two attacks of gonorrhea. Inventory by systems was all answered in the negative. He used alcohol to excess occasionally and smoked twenty cigarettes daily. He was born in Mississippi but had lived the past two years in Texas.

Physical examination was completely negative, except for complaint of tenderness on deep pressure over the right lower quadrant.

The urine was normal; white blood count was 6,500, polymorphonuclears 70 per cent, lymphocytes, 30 per cent. Wassermann and Kahn reactions were negative. Gastrointestinal

was thought to be the tip of a well filled, upward and medially directed appendix.

Exploratory operation through a right rectus incision was performed under 15 cc. of 1:1500

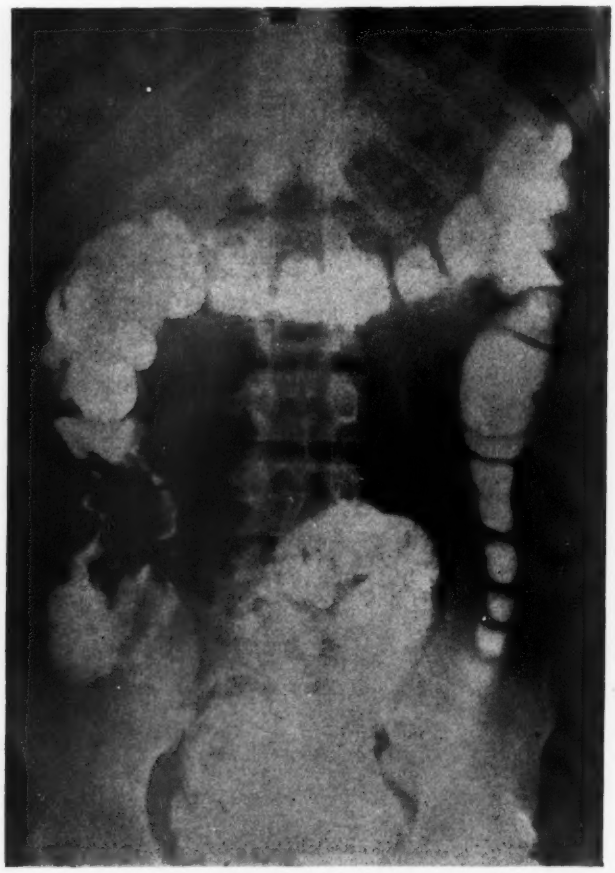

Fig. 2. Appearance with barium enema.

x-ray examination was negative except for continued spasm in the cecal region and the presence of a small residual mottled density at the mesial aspect of the ascending colon slightly above the level of the transverse process of the fifth lumbar vertebra. (Fig. 2.) His soreness disappeared and he was discharged from the hospital November 18, 1942.

After several more appearances at sick call, he was re-admitted December 16, 1942. Physical findings were still negative. A repeat barium meal showed cecal appearance as in Figure 1. Figure 2 shows the appearance with barium enema. Considerable spasm was present, at each examination, in the freely movable cecum, and it was difficult to make it fill well. The small mottled density seen previously appeared to be in the wall of the colon, medial to a constantly unfilled area, and near what

nupercain solution intrathecally, December 19, 1942. A small, movable retroperitoneal mass was felt at the location of the mottled density. The appendix was not seen until the cecum was well mobilized, at which time the appendix was found to extend upward 2.5 cm. from its base (Fig. 3A), and joined a 2.0 cm. wide by 1.5 cm long, rounded mass (Fig. 3B), itself joining the ascending colon 5 cm. above the base of the appendix. The mass was of doughy consistency. The contents were expressed into the colon. From the mesial aspect of this adventitious structure a long, slightly thickened appendix extended downward and laterally toward the tip of the cecum. (Fig. 3C.) (We had mistaken the direction of the appendix.) The distance on the mesial wall on the ascending colon, (Fig. 3D) between the base of the appendix and the attachment of the

fistulous tract was slightly more than 5 cm. No other abnormalities were found.

The appendix stump and colonic end of the fistulous tract were treated, after division between clamps, by inversion without ligation. The wound was closed in layers with interrupted silk sutures. The patient made an uneventful recovery.

The appendix was 14.5 cm. long, rather sharply angulated 2.5 cm. distal to the divided end at which site a smooth, tubular lateral projection extended 1.2 cm., with a diameter roughly twice that of the appendix. No marked constrictions were noted in the lumen of the appendix. Section of appendix was normal in appearance except for the presence of a few eosinophiles. The fistulous tract was lined with mucosa without crypts. No muscular layer was present.

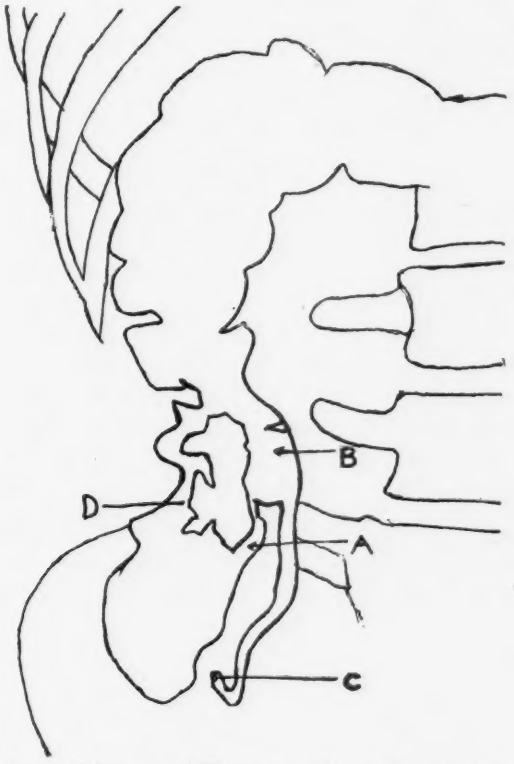

FIG. 3. Diagram of Figure 2. A, base of appendix; B, fistulous tract; C, tip of appendix; D, ascending colon, spastic.

SUMMARY

1. A case history is reviewed in which an appendiculocolic fistula is presumed to have been due to intracolic rupture of an appendiceal abscess.

2. The *x*-ray appearance of cecum and ascending colon indicated persistent spasm of the cecum and slow emptying of the fistulous tract.

ACUTE SPONTANEOUS PERFORATION OF THE GALLBLADDER

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PERFORATIONS of the gallbladder are divided into the acute, subacute and chronic types, depending upon the rapidity of the perforation, and occur in from 1 to 3 per cent of all cases of biliary disease with an average mortality of about 40 per cent.[1] The highest mortality, about 50 per cent,[2] occurs in the acute type, because the gallbladder contents are disseminated freely into the peritoneal cavity. The vast majority of acute perforations are associated with stones and a history of long standing gallbladder disease. The condition is usually diagnosed perforated peptic ulcer, ruptured appendix, high intestinal obstruction or acute cholecystitis, so that the correct preoperative diagnosis is rarely made. The treatment is early operation.

The following case is reported because it presents several interesting and unusual factors:

CASE REPORT

An obese female, age forty-nine, short in stature and weighing 306 pounds, was admitted to the surgical service of the Delaware County Hospital, March 13, 1937, at 11:50 P.M. with severe abdominal pain. For many years she had mild indigestion for which she had never consulted a physician. There was no history of jaundice or colicky pain. While seated in a moving picture theater she was suddenly seized with a severe, sharp pain in the epigastrium, accompanied by nausea and weakness. With assistance she walked to the rest room, where bicarbonate of soda was given and promptly vomited. Because of the continuance of the symptoms, the patient was removed to the hospital one hour later. By this time the pain had extended along the right side of the abdomen into the pelvis and was associated with pain at the tip of the right shoulder. The abdomen was generally rigid and more tender on the right side, but the extreme obesity prevented any definite localization. Her temperature was 97°F., pulse 112, respiration 28, blood pressure 160/90; hemoglobin 65 per cent, red blood cells, 3,780,000, white blood cells 12,900, 74 per cent polymorphonuclears with 25 per cent nonsegmented. Urinalysis was normal. A preoperative diagnosis of perforated peptic ulcer was made and operation performed one hour after admission, using nitrous oxide and ether anesthesia.

On opening the abdomen through an upper right rectus incision a moderate amount of greenish-brown fluid was encountered free in the peritoneal cavity, chiefly on the right side. The stomach and duodenum were negative. There was a large impacted stone in the neck of the gallbladder and just above this there was a perforation about one-half inch in diameter. There was no evidence of acute cholecystitis. The stone was removed through an incision in the fundus, following which the perforation was repaired and the gallbladder drained by means of a rubber tube through the fundus. Two cigarette drains were placed in the gallbladder region and one suprapubically. The maximum temperature and pulse were 101 and 120, respectively, on the second day and remained normal after the fourth day. Bile drained freely through the gallbladder tube, which was removed on the thirteenth day without complications. The cigarette drains were removed on the fifth day. She was discharged on the thirty-fourth day without symptoms. After four years she is still well with the exception of an occasional mild indigestion.

CONCLUSIONS

1. The diagnosis of the acute type of perforation of the gallbladder is difficult and rarely made preoperatively.
2. Its mortality is extremely high.
3. Prophylactic calculus cholecystectomy, thereby reducing the incidence of perforation, is the best way to lower the mortality.

4. Acute perforation of the gallbladder can occur without acute cholecystitis.

5. The treatment is early operation.

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Early establishment of external communication of the terminal bowel is indicated in complete atresia of the anal canal or rectum. When stenosis alone is present, dilatation with bougies or the little finger well lubricated suffices. In external fistulous termination of the rectum in the male and vaginal communication in the female, no indication for immediate operative intervention usually exists.

From "Intestinal Obstructions" by Owen H. Wangensteen (Charles C. Thomas).

REMOVAL OF VULVAE AND PERINEAL BODY BECAUSE OF SQUAMOUS CELL EPITHELIOMA

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REMOVAL of the perineal body is seldom necessary but can be done. In this particular case a neglected squamous cell epithelioma, starting along the posterior margin of the vaginal inlet, had deeply invaded the perineal body. The pain, accompanying the ulceration of the growth, rendered sexual intercourse impossible and disturbed the patient night and day until she had become a narcotic addict. Even while using large doses of morphine the patient was in such pain that she could not sit or walk or lie on her back. She rolled in bed, moaning constantly even when sleeping for short intervals. Her general health was disturbed and she was emaciated, having lost nineteen pounds during the past six months.

Consultation resulted in recommendation of removal of the perineal body by means of bipolar high frequency electrocoagulation. Under avertin anesthesia, the posterior two-thirds of both vulvae and the entire perineal body were removed leaving the anterior rectal wall and approximately half of the anterior portion of the anal sphincter. The use of the coagulating electric current avoided all bleeding so no sutures were necessary. No vaginal pack was used and normal saline vaginal irrigations three times daily were begun as soon as the patient recovered from the anesthetic. She slept soundly the night following the operation and has had no pain since. Morphine was entirely withdrawn in ten days and the wound healed by granulation in six weeks. The patient's normal desire for food returned and she regained her normal weight in twelve weeks.

During the second postoperative week the anterior wall of the rectum gave way and she has a rectovaginal fistula so that stools come through the vagina. The patient has learned to regulate her diet so she defecates regularly but wears a perineal pad for safety. She goes about the work of a normal housewife and enjoys an otherwise normal life.

Infiltration of the perineal body is seen only in late cases of malignancy so that the problem of removal is seldom encountered. The vascularity of the parts and the lack of tissue to close the space present a difficult problem, solved, in this particular case, by the use of the coagulating high frequency electric current applied by use of a large indifferent electrode under the patient in contact with the skin and a pointed active electrode to remove the diseased tissue. The wound healed by granulation and completely epidermized without grafts.

In 1940, cancer was responsible for 158,335 deaths—a rate of 120.3 per 100,000 population in the United States. This represents approximately 10 per cent of all deaths. Twenty-five per cent of these deaths were due to neoplasms of the female genitalia. The 36,412 women who died from cancer of the breast and genitalia account for nearly 44 per cent of all cancers in women.

F. J. Taussig[1] reports 155 cases of cancer of the vulvae treated during the years 1911 to 1940. Surgery was used by him in all but thirty-eight cases. During the early part of this period he used radium and *x*-irradiation but soon abandoned its use because of the unsatisfactory results and painful sequellae. He prefers the removal of both sides of the vulvae and the inguinal nodes by his modified Basset operation in those suitable for such an extensive opera-

tion. In poor operative risks and usually in those patients over sixty-five years of age, he uses electrocoagulation to destroy the ulcerated mass and allay pain. By employing this technic, he has shown 58.5 per cent five-year cures in clinical grades I and II even though 41 per cent of this group showed lymph node metastases at the time of operation. The 155 cases reported by Taussig originated from the following parts:

	No. of Cases
Epidermal	104
Vestibular	11
Periurethral	12
Bartholin gland	9
Glans clitoris	2
Unclassified (advanced)	17

Fifty-seven per cent had lymph node metastases. The five-year results of the various types of treatment employed by him are as follows:

	Per Cent
Basset operation and vulvectomy	58.5
Superficial or incomplete node removal and vulvectomy	28.6
Vulvectomy only	8.2
Radiation	4.8
Palliative (no operation or radiation)	0.0

Berven[2] of the Radiumhemmet, Stockholm, reports 177 cases of cancer of the vulvae using the following methods of treatment, with corresponding five-year results:

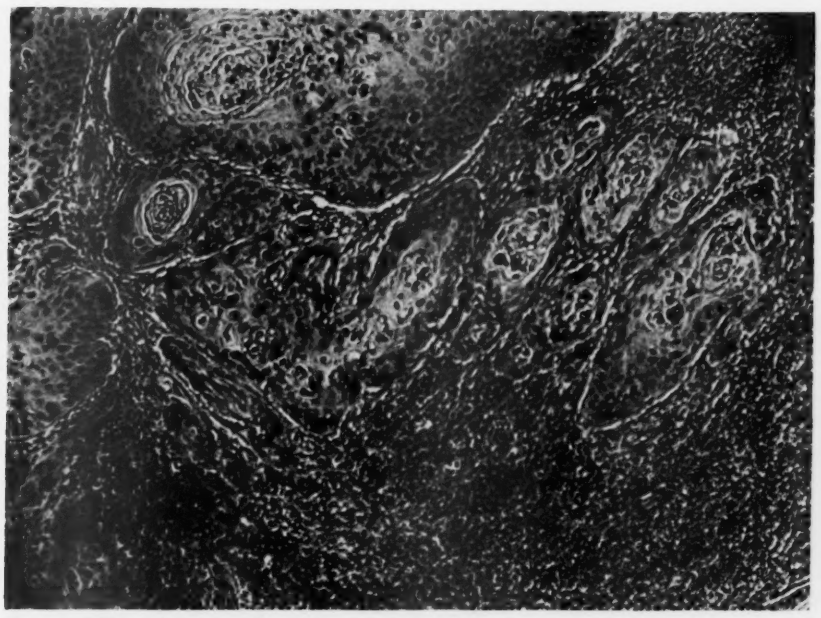

Fig. 1. Microphotograph of tissue removed for biopsy showing "overgrowth of differentiated squamous epithelial cells with both coarse and disseminated infiltration and frequent formation of epithelial pearls. Squamous cell carcinoma. Grade 1"—Dr. E. G. Eggers.

	Per Cent
Clinical grade I no nodes—vulvectomy and radium on nodes	59.3
Clinical grade II secondary nodes—vulvectomy and radium on nodes	22.9
Clinical grade III inoperable metastases—radium only	3.8

Berven uses electrocoagulation to remove the vulvae instead of the sharp knife, claiming the following advantages: no bleeding during operation, little postoperative pain, less infection, lower postoperative mortality—8.5 per cent—and soft scar.

CASE REPORT

Case No. 54945. Mrs. Wm. E., twenty-seven years of age referred by Dr. Louis Moon, stated that six months previously she went to a physician because of pain at the inlet of the vagina. On the diagnosis of cancer, repeated radium treatments were given in the office. In spite of the treatment the pain increased and the tumor grew larger until she could scarcely

walk or sit and had to lie face down to sleep. Large doses of morphine were necessary to control the pain.

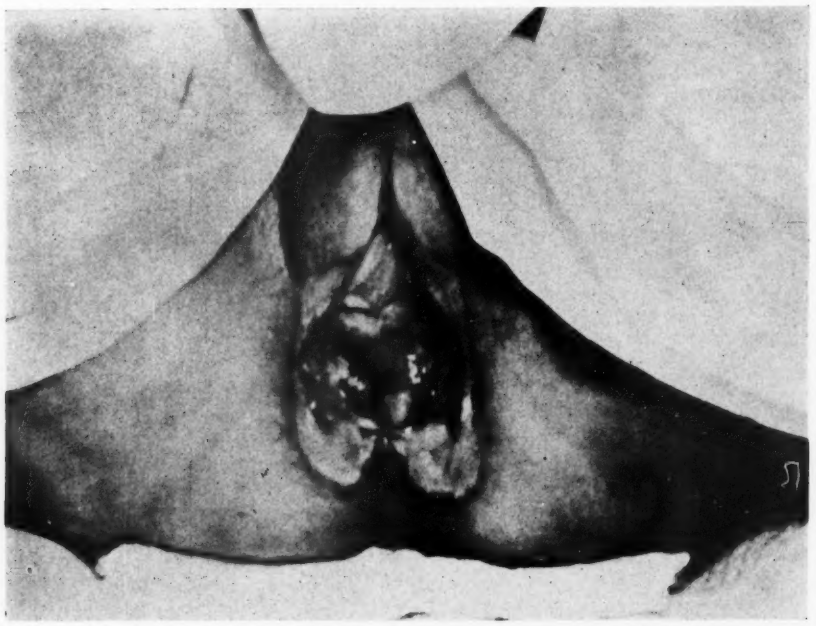

FIG. 2. Photograph of vulvae and perineum at present time showing complete epidermization and slight prolapse of the rectal mucosa into the vaginal canal.

Physical examination revealed an ulcerated, indurated new growth involving the posterior one-third of both vulvae and the fourchette, accompanied by extension deep into the perineal body. Small nodes were palpable in both inguinal regions. Otherwise the examination was negative.

Tissue removed by Dr. Moon for biopsy showed squamous cell epithelioma.

Under avertin-ether anesthesia the posterior two-thirds of both vulvae, the entire perineal body and anterior rectal wall down to the mucosa and the anterior half of the anal sphincter were removed by electrocoagulation. There was no bleeding during operation, no postoperative pain and the wound healed by granulation in six weeks, covering over with epithelium. The anterior rectal mucosa gave way during the second postoperative week resulting in a fistula with moderate prolapse of the rectal wall. Outside of this difficulty an uneventful recovery was made. Postoperative high voltage *x*-irradiation was given over each inguinal region using the following factors: 200 K.V., Thoraeus A filter, 50 cm. distance, 200 r daily, total dose 1,600 r each area.

The patient was well and showed no evidence of recurrence or metastasis two years and eight months after the operation.

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PRIAPISM*

CASE REPORT AND REVIEW OF THE LITERATURE

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TRUE priapism is a persistent painful penile erection usually unaccompanied by sexual desire. It is a rather rare pathological condition although the underlying disease processes of which it is a symptom are not uncommon.

Hinman[11] reviewed the literature in 1914 and reported 170 cases. His has been the most extensive review of priapism. In 1923, Planer and Kutzman[17] reported one case of their own and added thirteen from the literature. McKay and Colston[14] added three of their own in 1928 and collected nineteen from the literature. Since McKay and Colston's report thirty-seven additional cases have been reported in the English and American literature, mostly case reports. No doubt many more cases have occurred than have been reported as the disease processes causing priapism are not uncommon. It has been stated by Dawson[8] that fully 25 per cent of all leukemia cases are accompanied by priapism.

Etiology. There are many different etiological factors involved in the development of priapism. Hinman's suggested classification is the most widely accepted: (1) *Cases resulting from nervous causes:* (a) From ascending peripheral stimuli (reflex) such as inflammation, infection or tumors of the urethra; (b) from direct stimuli to the spinal cord center or to the nervous system; (c) From descending cerebral stimuli, direct and indirect, traumatic, neoplastic, inflammatory, or functional disease of brain or spinal cord. (2) *Cases resulting from local mechanical causes:* (a) Hemorrhage and hematoma; (b) thrombosis and pseudothrombosis; (c) new growths, and (d) inflammatory swelling and edema.

However, it is difficult to see just where some of the diseases known to cause priapism would fit into Hinman's classification. As Barney[1] has stated in his care of priapism as the initial symptom of splenic leukemia, "whether it is a thombis from excessive myelocytes or a thrombis of the ordinary sort I do not know." Further priapism occurs as a result of metastatic malignancies such as the case of Craig[5] in which hypernephroma metastases occurred to the corpus cavernosum. While this could be classified as a mechanical cause, the underlying process is fairly remote. Also a more recent etiological factor has been reported by Finkler[9] who had a case of seventeen days' duration following treatment of a eunuch with testostrone proprionate.

It is suggested that a simpler etiologic and anatomic classification would be:

A. Primary causes of priapism

1. Post urethritis
2. Local malignancies
3. Bladder stone. Hinman mentions priapism as a frequent symptom of bladder stone in children.

B. Secondary causes of priapism

1. Leukemia. Brown and Diog[4] report a case in which priapism was the first symptom of myeloid leukemia in an otherwise healthy laborer.
2. Multiple sclerosis. Wilgus and Fells[19] reported a case of priapism as the early symptoms of this disease.
3. Central nervous system syphilis. Hinman reports priapism in a newborn congenital syphilitic.
4. Cord injuries and inflammation
5. Cerebral hemorrhage
6. Neurasthenia. This has been well described by Huhner[12] and Oberndorff.[16]
7. Male sex hormone injections are reported by Finkler.[9]

* From the Clinic of Gamble Brothers and Archer, Greenville, Miss.

8. Sickle cell anemia as reported by Dawson.[8]

Pathology. The pathological reaction of priapism consists of the distention of the venous sinuses of the corpus cavernosa, usually the corpus spongiosum and glans are not involved. Colston and McKay[14] state that thrombosis occurs if the priapism exists more than two days and believe that regardless of the cause the priapism should be treated by some method that will remove the thrombis. Huhner[12] states that his experience does not bear this out. In his cases and in others cure has been effected without attacking the corpus cavernosa.

The blood in the corpus cavernosa in priapism is black, thick and stringy. There is usually a clonic contracture of the ischiocavernous and the bulbocavernous muscle.

Treatment. There are diverse forms of treatment suggested. Normally, the underlying cause should be treated. However, a persistent priapism, regardless of the cause is not only painful and leads to urinary retention but is also dangerous. Dawson reports a case of a patient who expired with gangrene of the penis. Therefore, a priapism of prolonged duration requires immediate attention.

The forms of treatment suggested are: (1) If the erection is sustained by the presence of a local malignant growth, radical amputation and resection of the inguinal glands is recommended. (2) Ligation of the dorsal arteries of the penis—close to the pubis. (3) Division of the ischiocavernous muscle. (4) Irrigation of the corpus cavernosa by the use of large aspirating needles and saline as suggested by Colston and McKay.[14] (5) Incision and drainage of the corpus cavernosa. (6) Epidural injection as recommended by Huhner.[12] (7) Ethyl chloride spray to the perineum as recommended by Nagel. (8) Intravenous 1 per cent mercurochrome has been used by Van Duzen. (9) Sedatives and ice bag; spinal and general anesthesia.

The following case is of interest because of (1) the multiplicity of methods of treatment used; (2) because no underlying cause could be found; (3) because of the successful outcome with complete functional recovery.

P. I. S. J., a seventeen year old colored laborer, was admitted to the hospital on April 24, 1942, complaining of a painful penile erection of six weeks' duration. For two weeks prior to the development of the condition he had been guilty of sexual excesses consisting of intercourse two or three times daily. The condition came on quite suddenly while sitting at home. He attempted to reduce it by frequent masturbation and intercourse without avail and three days after the onset he visited his physician. Sedatives and an ice bag to the perineum were used without avail and one week after the development he entered a State Hospital where pudendal nerve block was tried without results. He returned home after one week's hospitalization. At that time the condition was so painful that it was necessary for him to stay in bed; he could not void and catheterization was necessary. He was admitted to the hospital as a bed patient with his bladder distended to the umbilicus.

Physical examination showed a well developed and well nourished colored male; temperature 100°F., pulse 98, respiration 22. Physical examination was negative except for genitalia. The penis was in firm erection and lay back over abdomen. The base of the penis was stoney hard, the bladder was distended to the umbilicus. Blood count was as follows: white blood cells, 10,000; red blood cells, 4,250,000, hemoglobin 80, differential: polymorphonuclears 80 per cent, lymphocytes 19, monocytes 1. Urinalysis: specific gravity 1020, reaction acid, albumin and sugar negative. Microscopic examination: There were occasional pus cells. The blood Wassermann test was negative; the spinal fluid Wassermann was negative. Three cells; Pandy reaction negative. *X*-ray of bladder and pelvis was also negative.

During the first twenty-four hours after his admission to the hospital he was treated with ice bags to the perineum and morphine without change. In succession following this narcosis by intravenous pentothal sodium, spinal anesthetic and ether anesthesia were tried over a period of two days without change. On the fourth day after admission under pentothal sodium anesthesia two large No. 16 needles were inserted into the corpus cavernosa on

both sides and through and through, and irrigation with normal saline was accomplished. A large quantity of thick black stringy blood was washed out and immediately the penis became soft and pliable. Within four hours the patient was able to void spontaneously. However, about eight hours following this procedure the penis was markedly swollen and as hard as upon admission. On the following day under ether anesthesia the corpus cavernosa was opened on either side by a one-half inch incision. Much old, stringy, black blood was evacuated. The forefinger was pushed as far below and above as could be done in the corpus cavernosa. A gauze pack was placed in both sides and no closure of the skin made. The penis was soft immediately after this procedure. The patient voided freely after recovery from the anesthetic.

The gauze packing was removed in forty-eight hours. The wounds healed in seven days and the patient was discharged in good condition. He was seen six weeks later at which time there was no deformity of the penis and he reported that he was having normal erections two days after he returned home.

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PEDUNCULATED FIBROMYOMA OF THE INGUINO-ABDOMINAL REGION*

CASE REPORT

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FIBROMYOMAS may be found in any organ of the body which contains both smooth muscle fibers and connective tissue. Consequently, this type of a tumor must be considered in the differential diagnosis whenever a neoplasm is encountered in an organ containing both of these tissues. The most frequent site of occurrence of this type of a growth is from the uterine body itself with the remaining structures of the female genital tract being of secondary importance as to the point of origin of these tumors.

Taussig,[1] in reviewing the literature up to 1914, reports a total of 141 round ligament tumors, eighty of which had been previously reported by Emanuel. In 135 of this group the nature of the tumor was stated, seventy-nine belonging to the group of fibromyoma, including fibromas and adenomatous types of tumors in this classification.

In Taussig's group eighteen were reported as intra-abdominal and thirty extra-abdominal; while in Emanuel's series sixty were reported as being in the inguinal canal or labial folds, making a total of ninety extra-abdominal tumors. The type of tumor found in these different locations is not mentioned.

The age group in both was between thirty to fifty years; the majority occurred on the right side and were most frequently mistaken for hernia.

Horine[2] reviewed the literature from 1914 to 1933 and reported a total of thirty-six round ligament tumors, five of which were classified as fibromyomas. Here again, their exact location was not stated, but the age group and site of location corresponded with the résume as presented by Taussig.

In reviewing the literature to date I am unable to find a report of pedunculated fibromyoma occurring in the inguino-abdominal region with pedicle passing into the inguinal canal.

CASE REPORT

The patient, a female, was forty-eight years of age. The history and physical examinations were entirely irrelevant except for the presence of a lump in the left inguinal area which the patient stated moved around rather freely. It was first noticed about six months before the patient sought surgical relief.

Upon examination a mass, the size of a small walnut, was palpable in the left inguino-abdominal area above the region of the external ring. The ring could be palpated without difficulty and there was no impulse on coughing. The mass was well encapsulated and the outstanding clinical finding was the extreme mobility of the tumor within certain limits.

The preoperative diagnosis was not established and under local infiltrating anesthesia the tumor was removed by dissecting it free from the surrounding tissues and ligating the pedicle which entered the external inguinal ring. (Fig. 1.)

Fibromyomas of the inguino-abdominal region are among the rarest tumors found in this area. Grossly these tumors are hard and of a white, glistening appearance. They are well encapsulated and when incised allow the capsule to retract with a resulting projection of the tumor contents above the surface. The interior of the tumor has the typical whorl-like appearance characteristic of the fibroid group of

* From the Department of Surgery, College of Medical Evangelists.

tumors. (Fig. 2.) The microscopic pictures (Figs. 3 and 4) show the interlacing muscle fibers, some cut transversely and some cut longitudinally with the presence of varying amount of connective tissue.

If the possibility of the presence of this type of tumor is kept in mind a correct preoperative diagnosis can be made. The tumor is hard and well defined; but the most striking clinical finding is the extreme mobility of the neoplasm within certain limits. The mobility can be referred to as the so-called slip-away feel which is descriptively applied to fibro-adenoma of the breast and is absent in any other type of neoplasm found in the inguino-abdominal region.

Fig. 1. Tumor and pedicle.

Fig. 2. Showing glistening, pearly white tumor with characteristic whorls. The eversion of tumor contents after incising the capsule is also noted.

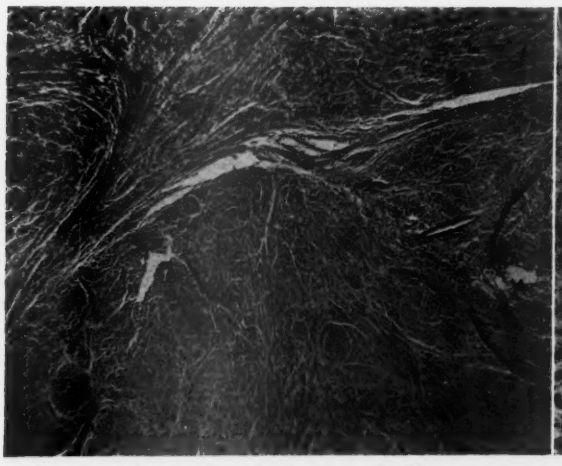

Fig. 3. Showing interlacing muscle fibers, some cut transversely and some longitudinally, with the presence of varying amounts of connective tissue. × 37.

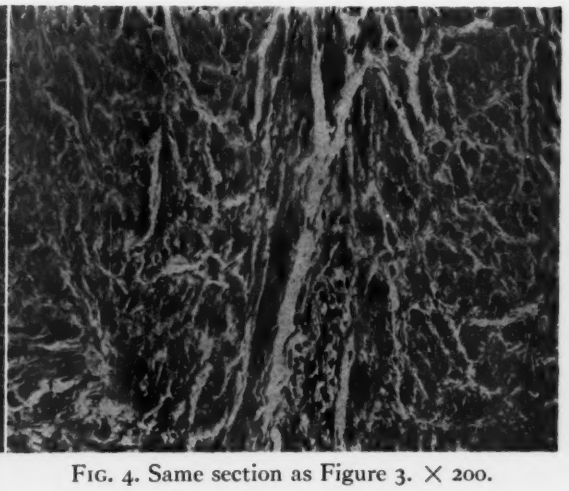

Fig. 4. Same section as Figure 3. × 200.

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Bookshelf Browsing

SOVIET MEDICINE

HERMAN GOLD, M.D.
CHESTER, PENNSYLVANIA

RADIO Moscow reported the Russian Army advancing on six fronts, the capture of dozens of towns and villages almost every day, the annihilation of the remnants of the German divisions caught in the pocket at Stalingrad, and the rehabilitation of village after village wrested from Nazi hands. And Radio Moscow also reports that, on the heels of the Red Army, come special medical squads of the People's Commissariat of Health Protection to eliminate one of the aftermaths of the Hitlerite "new order": epidemics, chiefly typhus. These medical groups consisted of 1,740 doctors and 5,000 nurses sent to the liberated towns and villages.

Supplied with the necessary medicines and instruments, they are sent to give aid in many villages of the Rzhev District and the Orel Region. There retreating Germans, flinging hand-grenades into basements where women and children had hidden during the fighting, had inflicted a large variety of wounds which made it imperative for Soviet surgeons to perform complex operations on the spot.

After rendering medical aid to the liberated population and trying to restore health to children in a state of complete physical collapse as a result of prolonged starvation, the squads proceed to restore medical institutions destroyed by the Germans. Latest statistics show that the Russian Government has spent 8,000,000 rubles, opened 211 hospitals and eighty-seven nurseries, forty-one children's health centers, 242 anti-epidemic centers and fifteen maternity homes in the liberated districts of the Kalinin, Kursh, Voronezh, Orel and Smolensk Regions. Squads have left for liberated districts in the Stalingrad and Velikie Luki areas to render aid to the population.

Naturally, the medical arm of the Red Army has learned a great deal during the nineteen months since the Nazis attacked the Soviet Union on June 21, 1941. In the words of Dr. Nikolai Burdenko, member of the Academy of Sciences of the U.S.S.R. and Chief Surgeon of the Red Army, particular attention was paid, in organizing the war medical service, to the organization of the American army by studying thoroughly the official reports and articles in different journals.

"We are familiar with such names as Finney, William, Mayo, Peck, Cushing, Goldwhite, Young, Blair, etc.," said Dr. Burdenko. "Modern surgeons such as Roman, Torek, Grotty and Olby are well known to us. The chief military medical administration of the Red Army concentrated its attention on the medical service of the American army, as this corresponds more nearly to the suggestions of the government and to the attitude of scientific circles.

"The aims of our military medical administration were the following:

1—Wartime surgery should be based on the achievements of modern science theoretically as well as practically.

2—Wartime surgery should be carried on by competent physicians.

3—The organization of military medical service of the military field of surgery in particular should have an inexhaustible supply of materials, such as drugs, bacterial preparations, equipment, instruments and *x*-ray apparatus.

4—Special attention should be paid to the health of the army personnel, primarily to preventive inoculations.

"With these principles in mind, the military medical service was organized as follows:

1—The specialization principle has been followed with regard to surgery, as well as to therapeutic and health hygiene.

2—Much care has been given to the instructions of specialists in major abdominal surgery, traumatology, mandibular facial surgery, neurosurgery, roentgenology, internal diseases and sanitary epidemic infections.

3—All outstanding authoritative physicians of the country have been mobilized to serve as chief surgeons in the army and at the front.

4—The chief military medical administration of the Red Army disposes of a sufficient number of military schools to meet the requirements in medical personnel.

"Great experience has been gained from the severe battles against the foe, resulting in correctives in the organization of the military medical service. Thus the problems of blood transfusions were revised by supplying the army with medicines, bacterial preparations, instruments, etc. A study was made of toxoids, bacteriostatic and sulfonamide preparations, etc."

At present, the number of surgeons exceeds the total number of physicians in Czarist army. At the front, physicians and the whole medical personnel work shoulder to shoulder with the army men. A few months ago, a 70 per cent return of the wounded to the front was reported, and at the present time, this is bettered in many places by the return of even 80 and in instances 90 per cent of the wounded.

Naturally, there have been outstanding cases of individual heroism of surgeons and physicians during the past nineteen months. Last July, Professor Alexander Vishnevski, who had performed over 400 difficult operations in field hospitals, was completing one operation on an officer, wounded in the leg, when the patient was struck by a machine gun bullet from an enemy plane. Vishnevski proceeded immediately to extract the machine gun bullet and saved the officer's life.

Once this same professor drew blood from his own veins during an operation to give a transfusion to a small girl injured when an air raid shelter was blown in by a direct hit.

Surgeon Spasski, in another section of the front, was operating on a Red Army man for a hip wound when the patient complained of a severe pain and a feeling of heaviness in the wound. The surgeon discovered an unexploded 37 millimeter anti-tank shell imbedded in the flesh and successfully extracted it.

Since head wounds are particularly serious, it is interesting to note that Professor N. I. Propper-Grashchenkov, head of the Nervous Diseases Clinic of the All-Union Institute of Experimental Medicine, reports that out of ninety patients operated upon in his clinic between December 25, 1941, and March 25, 1942, the majority recovered.

"Many cases of recovery from really serious brain wounds that would formerly have been regarded as hopeless can be cited," explained Professor Propper-Grashchenkov. "In the case of Senior Lieutenant Perfiliev, wounded in the head during a raid on the staff headquarters of a German regiment of rapid-fire gunners, a bullet from an automatic fire-arm entered his head at the nape of his neck, passed straight through the entire left cerebral hemisphere and lodged in the left frontal region of the brain.

"On *x*-raying him in the clinic, we found the exact location of the bullet; the patient complained of splitting headaches, evidently due to the fact that some hair and perhaps also a piece of his hat, had been carried into the brain by the bullet. To remove the bullet by way of the opening it had made when entering the skull would have been practically impossible without cutting away a considerable portion of the

brain and thereby causing the patient to lose his power of speech, since the bullet had passed close to the speech centers in the left cerebral hemisphere.

"We resorted to trepanning. By making a small opening in the left frontal bone of the skull, we succeeded in removing the bullet, together with all foreign matter carried along. Lieutenant Perfiliev recovered rapidly."

The necessity for blood transfusions on the firing line has of course led to many improvements in this department of medicine. Army nurses carry trench packets for emergency cases, where there is no time for heating, shaking and the other manipulations that go with the application of the preserved blood of donors. These packets contain a Professor Seltsovky ampule which is provided with a sterilized rubber tube, needle and filter and is filled with blood of the so-called zero group. Thus the nurse can give the transfusion under enemy fire.

Another big achievement is the antishock liquid evolved by the same Professor. The action of this preparation was tested in the treatment of 1,000 cases of acute shock and in all of them it raised the blood pressure. The Learned Medical Council of the People's Commissariat of Health of the U.S.S.R. has permitted large-scale application of the antishock liquid in the Red Army medical service.

War brings with it all sorts of complications, for certainly the surgeons are not always on hand when men are wounded. Soviet surgeons have evolved a method of applying "white streptocide" which delays the spread of infection for twenty-four to forty-eight hours, thus gaining time for the surgeon. Professor Kupriyanov, chief surgeon of the Leningrad Front Area, reports that balsamic bandages on wounds have been effectively applied on the field.

"While in the first World War gangrene affected from 15 to 20 per cent of the wounded in various armies," said Dr. Kupriyanov, "and under certain circumstances even 60 to 70 per cent, early surgical treatment of wounds by methods preventing the spread of infection has limited the incidence of gas gangrene to only 1½ per cent of the total cases in the hospitals of Leningrad.

"Tetanus, the scourge of armies in past wars, does not threaten the Red Army, thanks to the routine application of antitetanus measures."

No less instructive are the experiences of physicians serving with the guerrilla fighters, physicians who must operate in the dark with no light except a torch with a weak battery, who must give blood transfusions under difficult circumstances, who must make up their minds quickly in the face of emergency with no one to consult.

Such a doctor is Alexander F., straight out of university medical school. On January 13, 1943, this young doctor wrote: "In my work I firmly adhered to the principles of medicine. When the war is over and the Nazis are finally destroyed, I shall go back to the clinics of my teachers, Stalin Prize Winner Spaskukotsky and Professor Rufano, and say: 'Thank you. You taught me a lot, but I have much more to learn.' "

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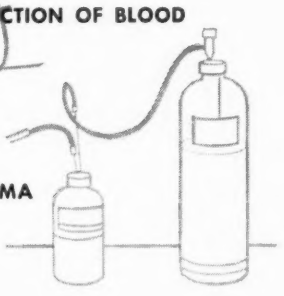
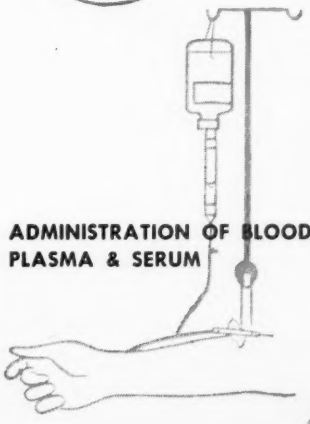


POOLING OF PLASMA



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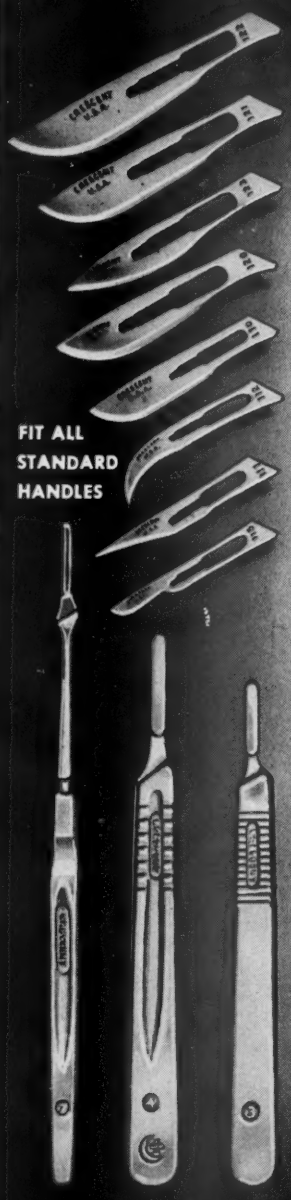

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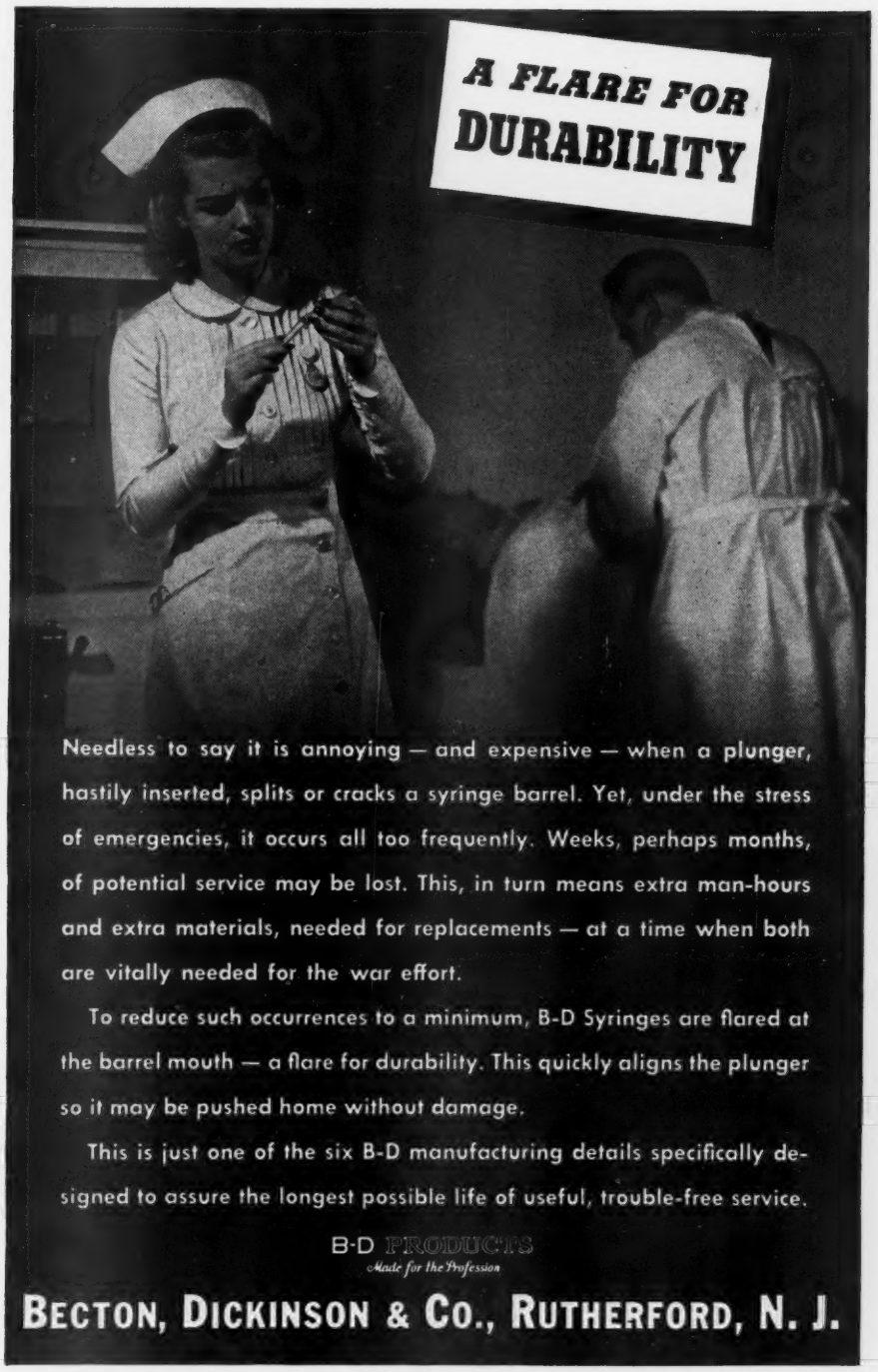

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[1] American Journal of Diseases of Children, Vol. 61, No. 1, January 1941
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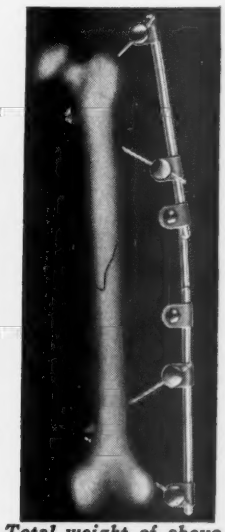

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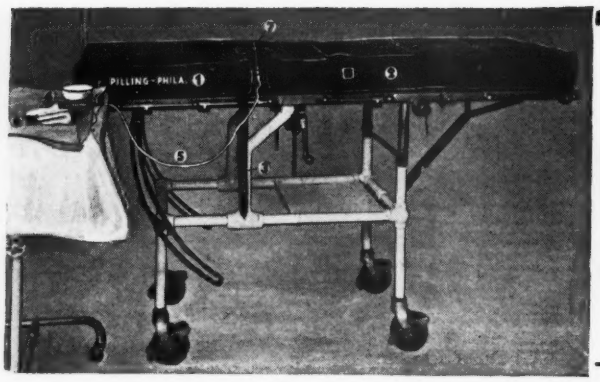

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*Himes, *Medical History of Contraception*

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